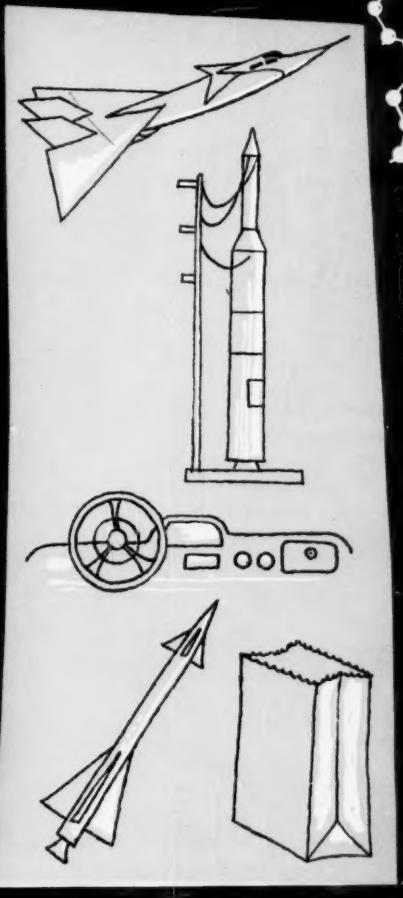
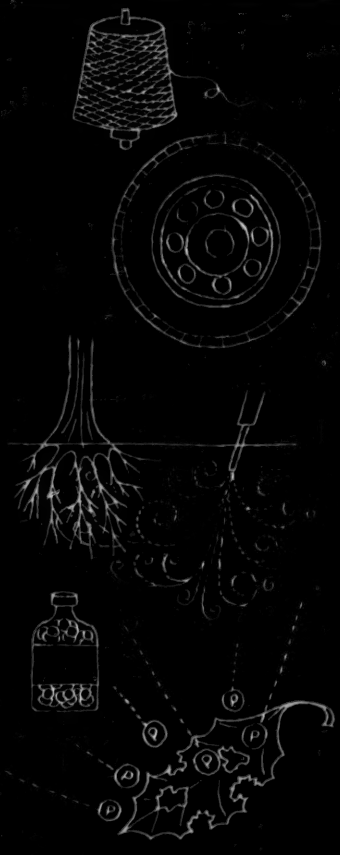
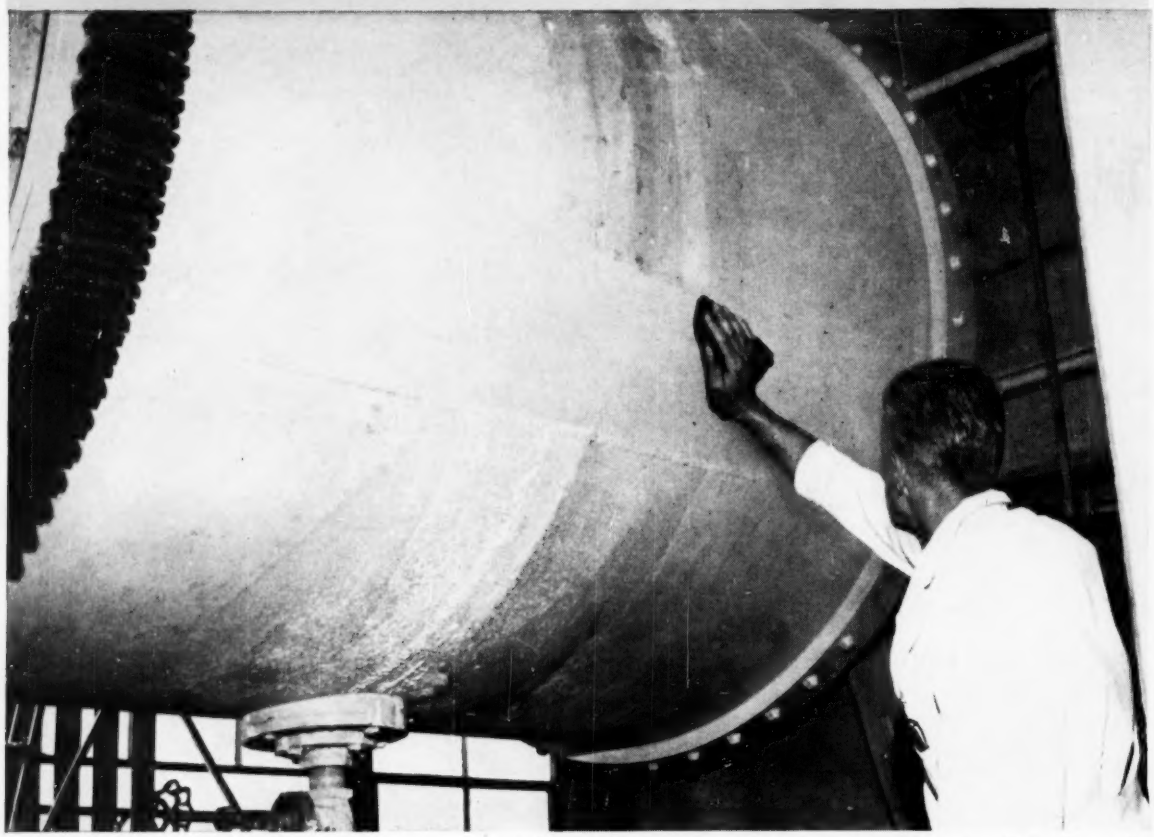
Chemical Engineering

chemical trends '59





At The Glidden Company...



At The Glidden Company, paint drippings from a pebble and steel ball mill are easily cleaned off the Epon resin-based exterior surface coating with a solvent-dipped rag.

Chemical-resistant Epon® resin-based coatings guard paint production equipment from corrosion ...greatly reduce maintenance costs

At one of the paint production plants of The Glidden Company, enamel coatings on equipment were often stripped down to bare metal in only 30 days by the corrosive action of caustic cleaners. Maintenance costs were high.

To reduce costs for general housekeeping and repainting, the grinding mills, storage tanks, structural steel, and concrete areas were coated with Glidden's own Epon resin-based paint, Nu-Pon Cote.

Even though the Epon resin-based coatings are constantly exposed to hot caustic soda solutions, solvents, paint splashes, and abrasion, a fast washing down with solutions of petroleum and ester solvents keeps them clean and bright. Equipment is completely free from corrosion. *The Epon resin-based coatings have already lasted 4 times longer than the previous enamels.*

Most paint users are already aware of the many advantages offered by Epon resin formulations . . . excellent adhesion, resistance to abrasion, impact, heat, and humidity extremes.

Your Shell Chemical representative will explain how you can take full advantage of Epon resins in your paint and enamel formulations. Write for EPON RESIN ESTERS FOR SURFACE COATINGS.

SHELL CHEMICAL CORPORATION

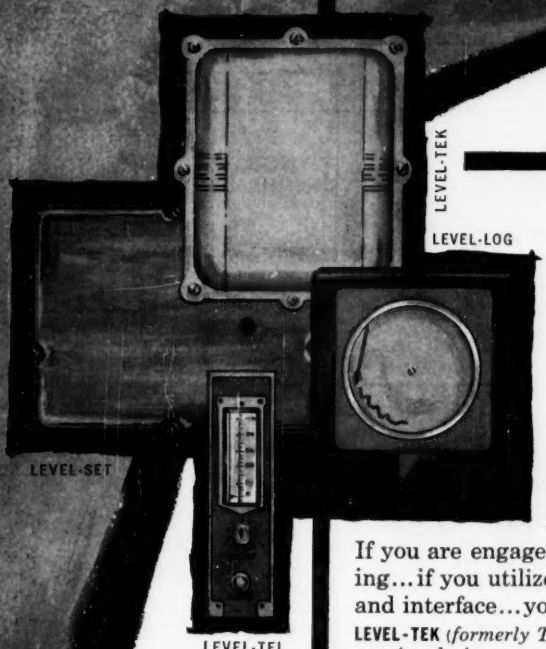
PLASTICS AND RESINS DIVISION

Atlanta • Boston • Chicago • Cleveland • Detroit • Houston • Los Angeles • Newark • New York • San Francisco • St. Louis

IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited, Montreal • Toronto • Vancouver

SHELL

IMPORTANT ANNOUNCEMENT



New family name for Robertshaw level measurement and control instruments

Effective January 1, 1959, Robertshaw will adopt more uniform and meaningful trade names to identify its line of capacitance instruments.

If you are engaged in mining, refining, processing or manufacturing... if you utilize or encounter liquids, granular solids, powders and interface... you can rely on these time-tested products.

LEVEL-TEK *(formerly Tektor)* – An on-off device which operates local or remote warning devices or motor-driven valves and pumps when a predetermined level has been reached.

LEVEL-TEL *(formerly Telstor)* – A continuous level system which detects, measures and visually indicates changes in media level.

LEVEL-SET *(formerly Pneutronic Level Controller)* – An instrument which converts changes in level to proportional changes in air pressure for maintaining a constant head in vessels where pneumatic feed control systems are employed.

LEVEL-LOG *(formerly Series 42 Recorder-Controller-Indicator)* – A versatile and extremely accurate RF null balance capacitance system for level measurement, recording and control.

AERONAUTICAL AND INSTRUMENT DIVISION

Robertshaw-Fulton CONTROLS COMPANY

SANTA ANA FREEWAY AT EUCLID AVENUE • ANAHEIM, CALIFORNIA

7 WAYS TO SEPARATE SOLIDS FROM LIQUIDS

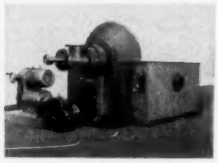
One of which will give you

• A BETTER PRODUCT • HIGHER OUTPUT PER DAY • LOWER COST PER TON

(in many cases, all three)

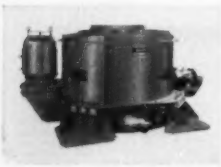
BIRD CONTINUOUS SOLID BOWL CENTRIFUGAL

employs positive, powerful centrifugal force to deliver dry solids, clear filtrates. Solids may range from a fraction of a micron to half inch or more; feed slurries may vary in volume and in consistency from 3% solids or less to thickener underflows. Operation is completely under cover. Cost of operation and maintenance is seldom more than a few cents per ton. Capacity ranges from 200 lbs. to 50 tons per hour.



BIRD-YOUNG ROTARY VACUUM FILTER

a drum filter of unique design, with six to ten times the capacity per foot of filter area of ordinary vacuum filters. Virtually the entire drum is under vacuum. This means unusually dry filter cakes. Pneumatic cake removal permits handling of slow filtering solids at high drum speeds. Unrestricted filtrate flow further increases capacity. Multi-stage, countercurrent wash with sharp separation of each wash liquor from filtrate. Readily made fume or vapor tight.



BIRD-HUMBOLDT OSCILLATING SCREEN CENTRIFUGE

combines centrifugal and oscillating forces to effect thorough dewatering of crystalline or granular solids; advantages include big capacity (up to 80 tons per hour), high solids recovery, almost no degradation of solids, long screen life (up to 3000 hours or more), low power input (0.2 KWA per ton of dried solids).

BIRD SCREEN TYPE CONTINUOUS CENTRIFUGAL

delivers dry, clean crystals from feed slurries high in solids content with solids relatively coarse; efficient wash, often with less than 0.1 lb. wash liquor per lb. of solids. Washes can be kept separate.

BIRD-PRAYON HORIZONTAL, PAN TYPE VACUUM FILTER

provides maximum effective cake wash with minimum wash liquor; as many as six washes can be made, each kept separate from mother liquor and each other; complete removal of cake after each operating cycle eliminates cloth blinding and assures long cloth life; high tonnage per unit of filter area; range of area is from 30 to 560 sq. ft.

BIRD SUSPENDED BATCH CENTRIFUGE

for heavy duty, high capacity operation, custom built to individual needs; equipped with gyro-balanced suspension head for smooth, non-swaying operation with heavily out-of-balance loads; 40″ or 48″ basket, perforate or imperforate; fume-tight or explosion proof if required.

BIRD PRESSURE LEAF FILTER

of advanced design and construction, providing great strength, large sustained filter area, high rate of flow, high working pressure (up to 75 psi standard, 250 psi special). Custom built for the job, of corrosion resistant alloys or special linings, as indicated; insulated, steam jacketed; wide range of sizes.

The BIRD RESEARCH and DEVELOPMENT CENTER

is a completely equipped and staffed test plant devoted exclusively to solid-liquid separation work. Pilot-scale tests are available to help you select the one best method and equipment for the job in advance of your equipment investment. It is yours to use.

BIRD
MACHINE COMPANY

SOUTH WALPOLE, MASSACHUSETTS

Regional Offices:

EVANSTON, ILLINOIS WALNUT CREEK, CAL. ATLANTA 9, GEORGIA

Chemical Engineering

JANUARY 26, 1959 **Vol. 66, No. 2**

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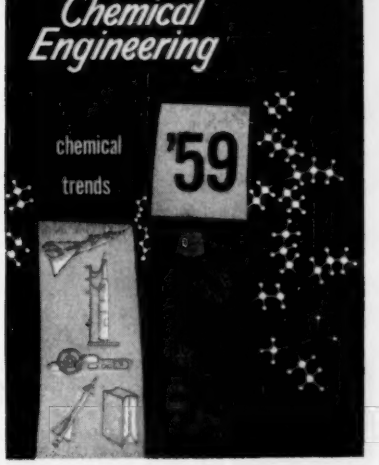


SECOND OF TWENTY-SIX 1959 ISSUES

2/26

Today's chemical newsmakers

Here's an interpretive scan of trends in our industries—the real hot developments to watch in 1959. And behind every one there are chemicals and chemical developments. For your convenience we've broken our report into 10 segments. But the common thread in the whole fabric is specialization—specific chemicals for specific uses. These pin-pointed products are going to be behind many of the chemical headlines you'll read during 1959. (p. 87)

Why urea is in the news

Urea capacity is going to be up about 50% by 1960. This issue of CE brings you a roundup of the five commercial processes responsible for the upsurge. They're all ready to step in and help meet expected new demands. And there's a peek behind the scenes to see how we wrapped up this package for you. (pp. 43, 78, 156)

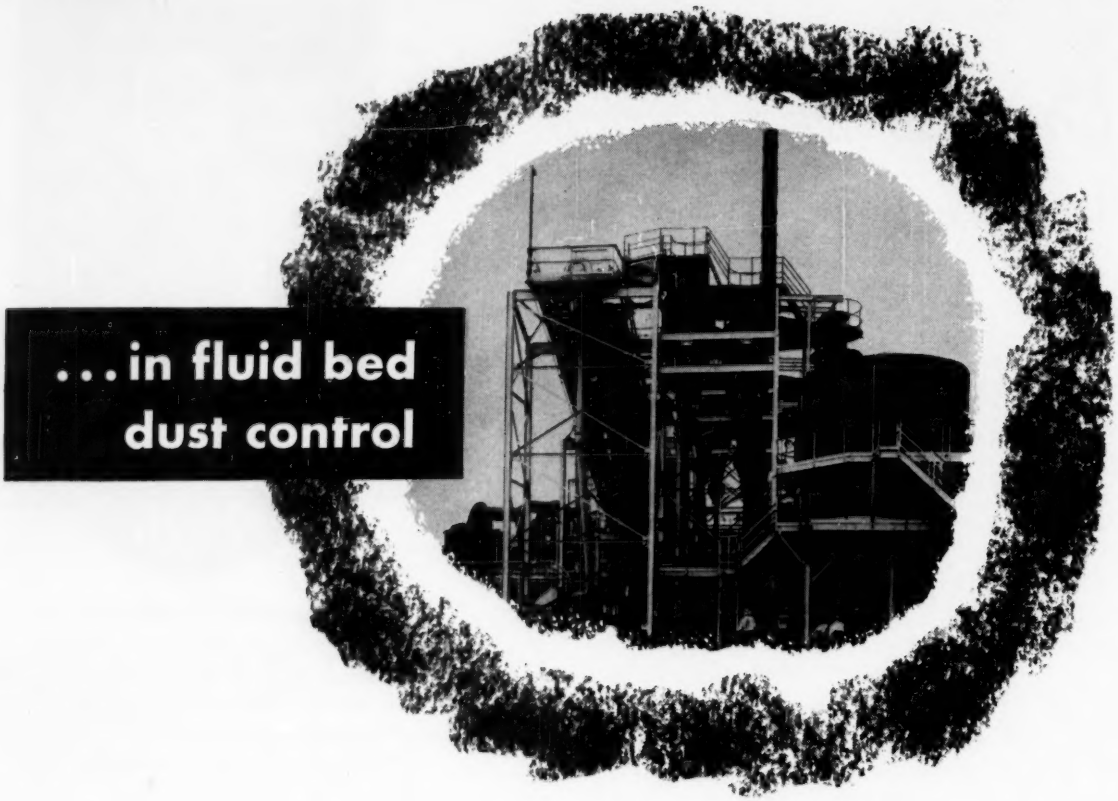
Quick way to radiant heat transfer

Four big new charts will do away with some of your complicated figuring. They give quick values for radiant heat exchange between hot gases and an enclosing wall. (p. 101)

The latest in overtime pay.

If your salary is less than $95 a week, you get time-and-a-half after 40 hours. That's the new regulation that goes into effect next week. If you earn more than $125: probably no overtime pay. In between, you'd better get a special ruling on your status.

Complete Contents: Page 5 ▶



DUCLONES® provide high recovery efficiency, insure continuous operation

DUCLONE high efficiency cyclone dust collectors are designed and constructed to take unusual service conditions in stride. That's why they have gained wide acceptance in fluid bed processes, such as the one illustrated for pyrite roasting to produce sulfur dioxide for manufacture of sulfuric acid. A special refractory lined primary Duclone and stainless steel secondary Duclones were supplied by Ducon to insure continuous operation under the inherent high temperature and corrosive conditions of the process.

High efficiency Duclones are available in a wide range of capacities and in multiple units and special materials to meet a wide variety of dry dust control applications.

Send for Bulletin C-958.

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DUCON — DUST CONTROL SYSTEMS AND EQUIPMENT

THE DUCON COMPANY INC.
147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

Canadian Branch:
THE DUCON COMPANY, INC. of CANADA, Ltd.,
1131 Pettit St., BURLINGTON, ONTARIO

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

Chemical Engineering

JANUARY 26, 1959 **Vol. 66 No. 2**

Edited for the engineers who develop, design, build, operate, maintain and manage chemical operations of all types. More engineers subscribe to CE than to any other magazine in the field. Print order of this issue: 48,886.

Developments in Chemical Engineering

Practice of Chemical Engineering

Other Regular Features

Reader Service

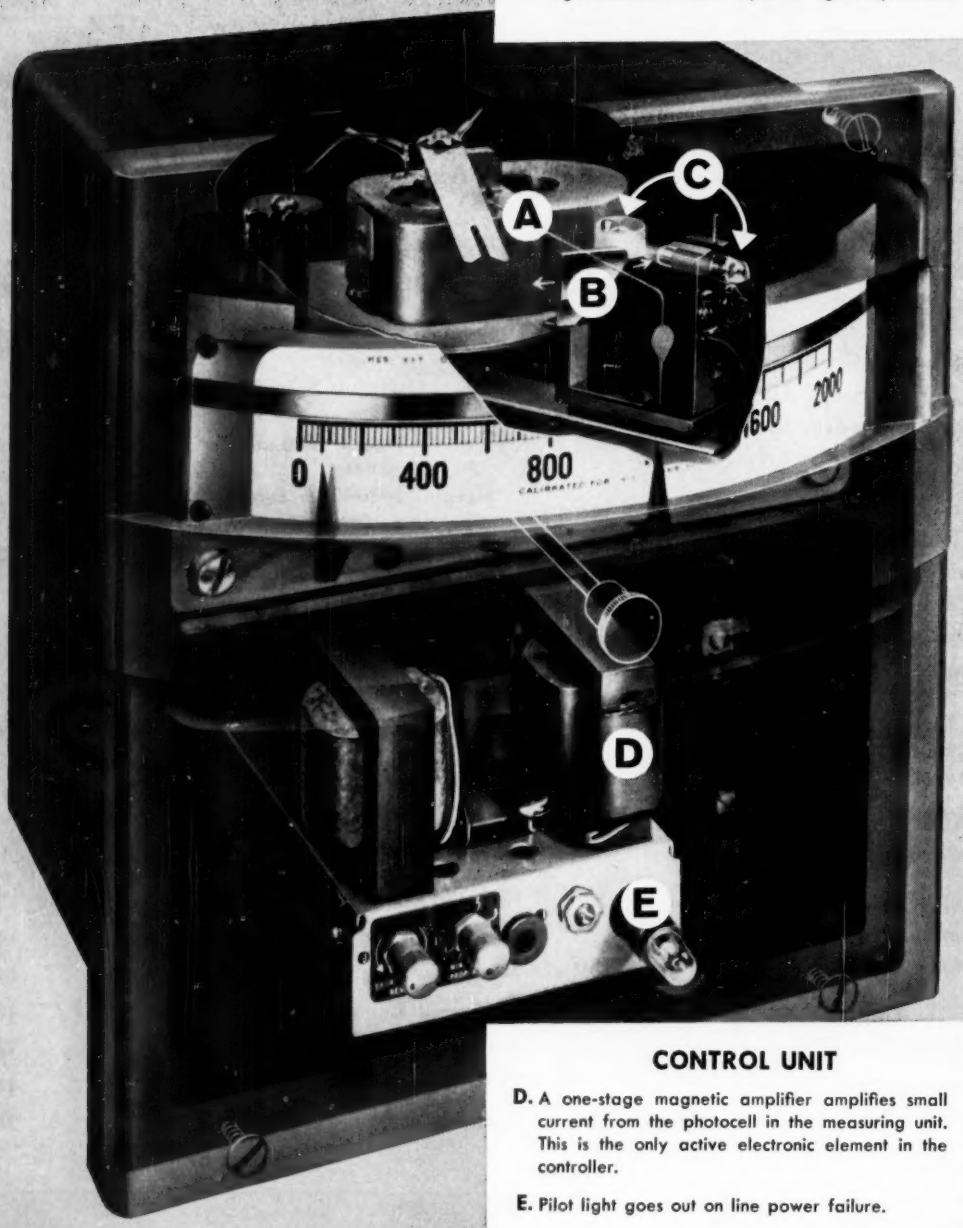
*Free—For your files—Check your Reader Service postcard (p. 166) for an extra copy of this design aid with its four big new working charts.

MEASURING UNIT

A. A thermocouple signal to a d'Arsonval galvanometer, the only moving part, moves the indicating pointer up scale.

B. Aluminum vane adjusts the amount of light received by the photocell from the operating lamp.

C. If operating lamp or photocell fails, output voltage assumes a value equal to high temperature.

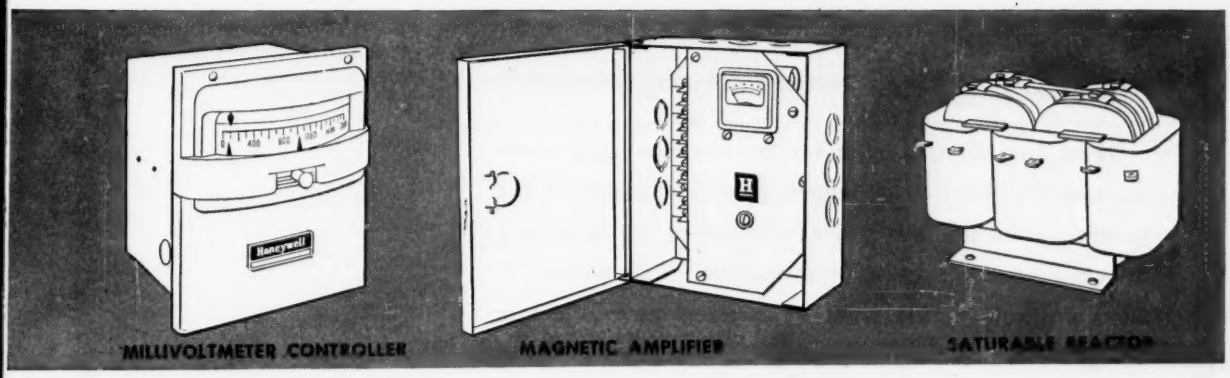


CONTROL UNIT

D. A one-stage magnetic amplifier amplifies small current from the photocell in the measuring unit. This is the only active electronic element in the controller.

E. Pilot light goes out on line power failure.

Pyr-O-Volt **controller is dependable and trouble-free. Built-in voltage regulator maintains voltage within ± 1% of level required for maximum operating stability. Thermocouple burnout protection is optional. Spare operating lamp is supplied with all instruments. Available in both horizontal and vertical case models.**



For your electric heating applications...

Use this accurate, dependable *Pyr-O-Volt** controller

- **No tubes to wear out**
- **Voltage regulation**
- **Fail-safe design**
- **Contactless, stepless control**

Here's an accurate instrument for reliable stepless control of saturable reactors, r.f. generators and other power amplifiers. It has a proportional band adjustable from ⅔% to 5%, and a manual reset adjustment which shifts the control point over 100% of the proportional band.

The *Pyr-O-Volt* controller can control saturable core reactors up to 100 kva, if used with a Brown magnetic amplifier. You can also use this proportional output millivoltmeter-controller with the General Electric *Reactrol***, and with the Westinghouse *Furnatron*.*** Complete packaged systems available.

Contact your nearby Honeywell field engineer for complete details. He's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL *First in Control*

● **REFERENCE DATA: Specification S103-5**

*Tradename, Minneapolis-Honeywell Regulator Co.
**Tradename, General Electric Co.
***Tradename, Westinghouse Electric Corp.

DOW | **What's new in processing chemicals?**

News has a cash value for the chemical processor. Whether it's about new products or new applications for familiar products, this news can make the difference between keeping ahead of competition and having to catch up with it. This series of chemical news notes is designed to help you keep products, processes . . . and profits up to date.

You may wish to check certain items in this advertisement and forward to those concerned in your company.

Route to:

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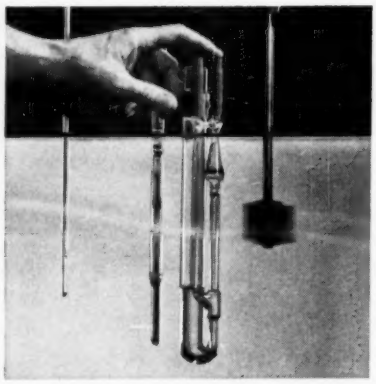
BIG STIR FOR BETTER SOLUTIONS CREATED BY 3 NEW METHOCEL PRODUCTS

Production managers are looking eagerly over the shoulders of their research chemists these days and nights as they work overtime to get the most out of three newly announced Methocel® (Dow methylcellulose) products.

These three new products expand the already unequalled Dow line of synthetic gums (industry's widest), making available viscosities ranging from 10 cps. to 15,000 cps. Together with new techniques for putting Methocel into solution, they promise to open whole new areas of profitable use for these water-soluble, non-ionic gums.



New high-viscosity Methocel being measured with pinpoint accuracy with Ubbelohde viscosimeter

Reports are coming in from textile, paper, food and paint laboratories all over the country.

Here's what they're saying about . . .

METHOCEL 60 HG — "Better organic solubility and compatibility than other water-soluble gums yet still retains its water solubility." "Great for industrial paint removers, alkyd modified latex paints and coatings that must lay down a film from an organic solvent for fast drying." "Can be plasticized and made thermoplastic to heatseal coatings." "Better emulsifier and emulsion stabilizer because it's more surface active than other water-soluble gums."

DOW CHEMICALS

ETHYLENE AMINES

Three higher amines offer challenging potentialities as intermediates: Diethylenetriamine, triethylenetetramine, tetraethylenepentamine.

GLYCERINE

Expanded production facilities furnishing uninterrupted supply of three grades, synthetic, USP and USP 99.5%—all of unexcelled purity.

POLYPROPYLENE GLYCOLS

Polypropylene Glycol P2000 RG is but one of six resin grades that assure users exact degree of firmness or hardness in polyurethane production.

METHOCEL 70 HG – "Exceptionally good for industrial emulsions such as asphalt and other petroleum based types."

METHOCEL 90 HG – "Completely solved our problem of thermal gelation." "No gelling at temperatures below 90°C. (194°F.) . . . at last we can take advantage of the non-ionic, surface-active and film-forming properties of Methocel."

METHOCEL 90 HG, 15,000 cps–"Very low concentrations of this high viscosity product gives us efficient thickening. Should result in substantial savings."

These reports have a familiar ring to the people at Dow. That's because they read like chapter and verse from the newly published Dow handbook on Methocel. This 60-page package of facts shows the versatility of Methocel as a thickener, stabilizer, film former, emulsifier and binder. In addition to describing the new products, it also reports on established members of the Methocel family . . . MC, 65 HG, CAM, AS-2, AS-4, and AS-8. Copies are available immediately from Dow.

After 20 years . . .

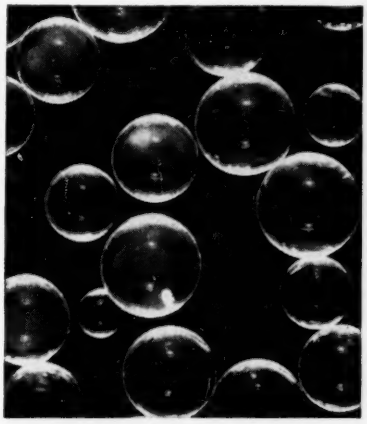
Ion exchange resins are being 'rediscovered'

In the 20 years or so since they were first discovered, ion exchange resins have softened oceans of water. These years of yeoman service have been worthwhile, but research chemists now probing the new uses for these resins find they've come across a basic, cost-saving industrial process with many really revolutionary uses.

"It's like discovering you've had an Einstein working as a file clerk," said one chemist. "We've found valuable new uses for ion exchange resins in concentration, conversion, fractionation, purification and catalysis."

Actually ion exchange might be considered the latest link in the chain of chemical processing evolution. Dow production and technical service personnel have geared themselves for the forthcoming expansion. Current users have found ion exchange practical and beneficial for such uses as uranium recovery, de-ionization of glycerine and sugar solutions, epoxidation catalysis, rare earth separations and recovery of metal finishing solutions such as chrome plating baths.

A big processing advantage in the ion exchange method, chemical processors are finding, is that ion exchange resins can be produced in an almost infinite variety to fit specific needs.



Increased bead strength and stability in new white cation resin, Dowex 50W.

These resins are manufactured by Dow under the trademark Dowex®. Dow technical service specialists are constantly helping chemical processors apply the principle of ion exchange to a multitude of manufacturing problems. Complete information on the various resins in the Dowex line and the countless specialized formulations possible is available from Dow.

This settles it:

Separan NP10 breaks flocculation bottlenecks

When it came to separating solids from liquids, a lot of chemical processors found that their biggest industrial waste was *time*. But that was before Separan® NP10.

A glimpse at the record of this high-speed flocculant shows why so many processors are impressed by its performance. A uranium ore processor reports: "With Separan NP10 we can make one thickener do the work of *five*." A copper processor says: "Increased settling rates with Separan NP10 increased our ore processing capability 1,600 tons a day, cut unit costs, and prevented bottlenecks."

The stop-watch of a West Virginia coal operator clocked Separan NP10 doing a two hour settling job in *seven minutes*. A paper mill superintendent explained that a small amount of Separan NP10 as a filler retention aid has decreased costs $10 per ton for 50 lb. offset bond while maintaining specifications.

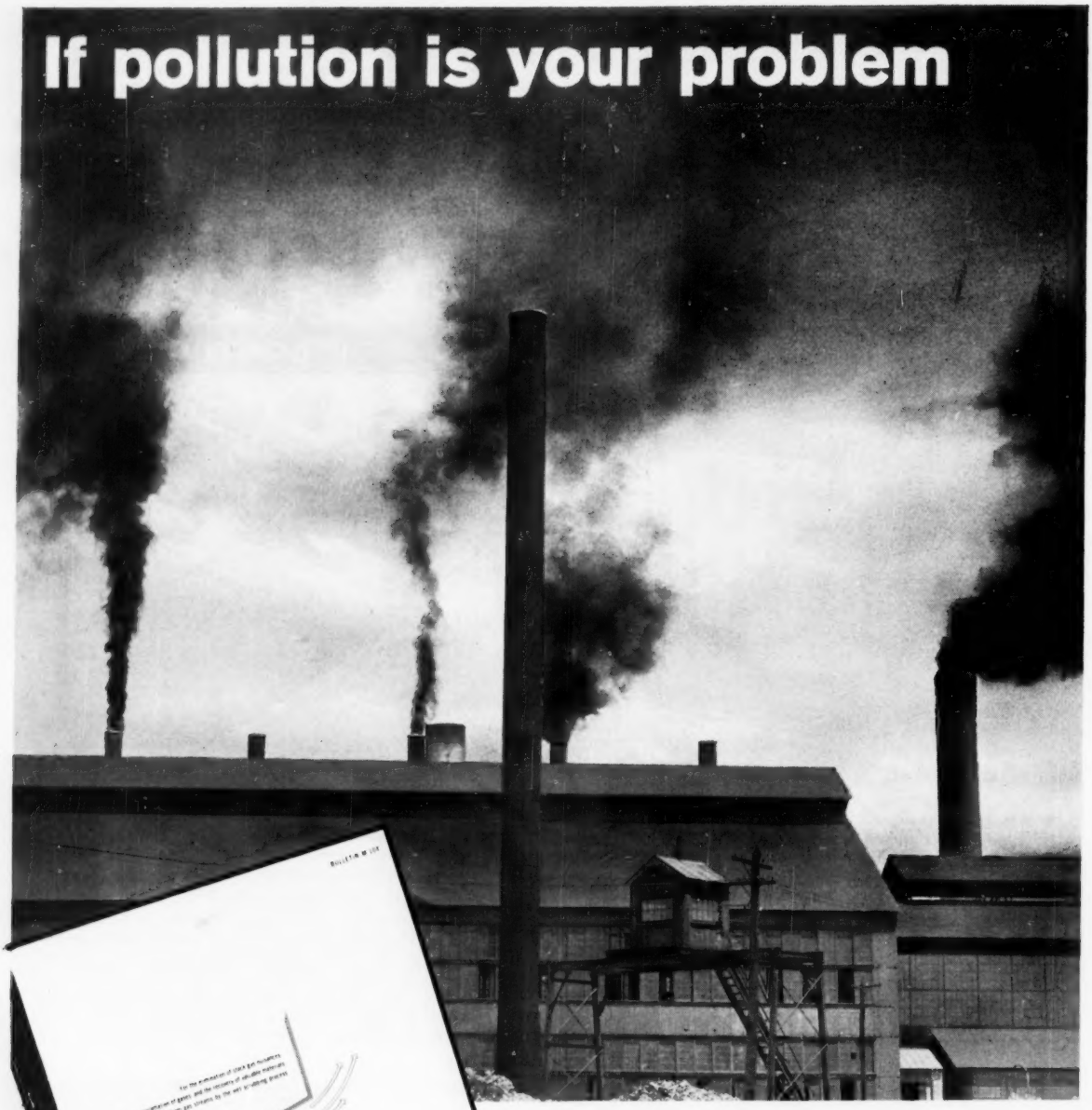
In an ever-widening variety of thickening, filtration and clarification applications, Separan NP10 is solving many problems, clarifying plant influents, providing cleaner recycle water, and increasing solids recovery. Results are continually startling new users.

As one processor put it, "We didn't even know we could improve the economics of our operation until we learned about Separan NP10. We're still amazed!"

* * *

If you aren't already profiting from these and other Dow chemicals, we suggest you write for complete information to THE DOW CHEMICAL COMPANY, *Chemicals Sales Department 910AK1-26, Midland, Michigan.*

If pollution is your problem



. . . Chemico venturi gas scrubbers normally offer elimination of plus- and sub-micron size dusts, fumes, mists and fogs. The new brochure you see illustrated gives full details on how this equipment is now providing clean, efficient, economical performance in many industrial applications.

If pollution is your problem, this new Chemico data-packed brochure may well give you constructive ideas on how to solve it. For your copy, write Department E1, Gas Scrubber Division, at the address below.

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
525 West 43rd Street, New York 36, New York

CHICAGO • DALLAS • HOUSTON • PORTLAND, ORE • TORONTO • LONDON • PARIS • JOHANNESBURG • TOKYO

FALK and STEELFLEX are Registered Trademarks

Cut disconnect-reconnect time by as much as 50%

The FALK Spacer Coupling is specially designed for quick installation or removal *without disturbing the driving or driven unit.* This feature can save you up to 50% in disconnect-reconnect time when critical equipment—a process pump, for example—needs repair or replacement.

Here's another saving: with the FALK Spacer Coupling, you can quickly realign shafts *without the usual loss of operating temperature!*

And still another: you can remove or reinstall the FALK Spacer as a unit *without draining the lubricant.*

Because of its exclusive grid-groove Steelflex design, the FALK Spacer can accommodate residual misalignment—parallel, angular, or (most important) *both.* Also, it provides torsional resiliency that cushions shock and vibration. Thus it saves wear-and-tear on your connected equipment.

To prove these claims and enjoy these savings, install a FALK Spacer on one application—and see for yourself. Consult your FALK Representative or Authorized Distributor.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

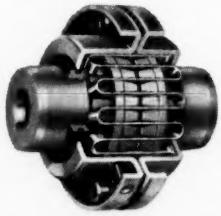
Representatives and Distributors in many principal cities.

EASY AND QUICK TO INSTALL, DISCONNECT OR RECONNECT

First, mount shaft hubs to allow proper distance between hubs; then, align driving and driven units.

Second, compress Spacer to fit space between hubs and tighten cap screws to pull spacer hubs into the registered fit.

To disconnect, reverse the second step. No draining of lubricant necessary.



The heart of the FALK Spacer ...the basic Type F Steelflex

Write for Service Manual 4838

FALK

...a good name in industry

ADVERTISEMENT—*This entire page is a paid advertisement* *Prepared by U. S. Industrial Chemicals Co.*

U.S.I. CHEMICAL NEWS

Jan. ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1959

Market for Rigid Urethane Foams Growing Rapidly

While rigid materials accounted for less than 10% of the total polyurethane foam market in 1957, 1958 figures are expected to show an increase to more than 20% of the total market. The Society of the Plastics Industry feels that by the end of 1959, 30-40% of the demand will be for the rigid foams.

The material is proving ideal for industrial and home insulation. Packaging applications are expanding. Makers of marine equipment are using the rigid foams for buoyancy. Military applications include radiation shields and heliohuts. More and more, structural panels and laminates are being made with rigid urethane foams.

Users can buy fabricated foam or they can foam the material themselves in place, by employing either molding or spraying techniques. Special equipment has been developed for spraying urethane polymer onto overhead, vertical or irregular surfaces. It foams and sets in place rapidly to give a rigid coat which will not slip, sag or fall away.

Rigid urethane polymers are formed by mixing two chemical components—polyisocyanates and polyesters. Carbon dioxide gas is given off during the reaction and it serves as a blowing agent which causes the polymer to foam in place. An intermediate that can be used to produce the polyester component is ISOSEBACIC® acid, a mixture of C-10 dibasic acids. ISOSEBACIC acid will be available soon in commercial quantities from a new U.S.I. plant at Tuscola, Illinois.

"Stabilized" Polyethylene Fabrics Now Being Made Via New Finishing Process

A patented technique for finishing polyethylene fabrics is now being employed to improve shrink resistance, strength, appearance and other physical characteristics. According to the patent, conventional finishing methods for polyethylene fabrics—calendering or hot fluid treatment of the greige goods to preshrink them—result in loss of yardage, strength and optimum appearance.

The patented process involves the pretreatment of oriented polyethylene filaments before conversion to give them a residual shrinkage of 8-20% (tested at 75°C for 20 minutes). The filaments are then converted to greige goods, in which they have a wavy form.

The greige goods are subsequently held along both the length and width to prevent retraction and are heated at a strictly controlled temperature for a limited time. So held and treated, the filaments in the fabric shrink to the extent of their residual shrinkage and straighten out, without reducing the area of the fabric.

By comparison with fabrics finished by conventional methods, these materials are said to have better appearance, strength and aging properties. The process is claimed to provide economies in operation — to save yardage and to reduce the number of finishing steps required.

Gov't. Authorizes Substitutions In SDA 40 Alcohol Formulation

Shortage of Brucine Denaturant Made Modifications Necessary.

SDA 40, which the U. S. Government authorizes for use in toilet goods, external pharmaceuticals, biocides, detergents, etc., has been formulated until now with ⅛ gallon of *tert.*-butyl alcohol plus 3 ounces of brucine alkaloid or 3 ounces of brucine sulfate per 100 gallons of ethyl alcohol. To relieve difficulties of denaturers and users of this formulation due to a critical shortage of brucine, the Internal Revenue Alcohol and Tobacco Tax Division (A. & T. T. D.) has authorized the formulation of SDA 40 with ⅛ gallon of *tert.*-butyl alcohol plus either 1½ ounces of brucine alkaloid, or 1½ ounces of brucine sulfate, or 1½ ounces of quassin per 100 gallons of ethyl alcohol.

How the Substitutions Came About

When the brucine shortage first became acute, an inability to meet customer requirements for SDA 40 threatened to upset the entire industry. Recognizing the situation, the A. & T. T. D. authorized quassin as an alternate denaturant.

While brucine is one of the bitterest materials known, quassin had been tested and found sufficiently bitter and acceptable from other standpoints to serve as an alternate denaturant. Quassin had been used as a denaturant in Canada for 25 years, and this experience dispelled concern about possible adverse effects arising from its use.

Samples of SDA 40 denatured with quassin were offered to the trade, and users were urged to make up their products with this alternate, to assure compatibility with their formulas. After testing, many customers advised that they would accept SDA 40 alcohol with this denaturant.

However, realizing that limitations on the supply of quassin made it an incomplete answer to the shortage, the A. & T. T. D. took quick action to extend existing supplies of brucine by authorizing denaturation with reduced quantities of brucine alkaloid and

MORE

SDA 40 AUTHORIZED USES
(Under Permit)

- Hair and Scalp Preparations
- Bay Rum
- Lotions and Creams (Hand, Face, Body)
- Deodorants (Body)
- Perfumes and Perfume Tinctures
- Toilet Water and Colognes
- Shampoos
- Soaps and Bath Preparations
- External Pharmaceuticals (not U.S.P. or N.F.)
- Disinfectants, Insecticides, Fungicides and Other Biocides
- Cleaning Solutions (including Household Detergents)
- Theater Sprays, Incense and Room Deodorants
- Miscellaneous Dye Solutions
- Miscellaneous Solutions

Vitamin C Indicated for Virus & Other Infections

Several medical investigators have found that continuous massive doses of ascorbic acid (Vitamin C) are effective in treating virus diseases such as polyiomyelitis, measles and virus pneumonia; bacterial infections such as tuberculosis and scarlet fever; and cases of poisoning such as snake bite and lead poisoning. The range of antibiotic and antitoxic action is said to be unusually broad, and, in addition, there is claimed to be *complete freedom from allergic or toxic reaction.*

Intravenous or intramuscular injection is the preferred method of treatment. When so administered, ascorbic acid is said to compare favorably with sulfa drugs and mycelial antibiotics. Effectiveness of the therapy is reported to be dependent upon the potent oxidation-reduction action of ascorbic acid, which rapidly neutralizes viral or bacterial toxins.

Ascorbic acid occurs naturally in citrus and other fruits, as well as green leafy vegetables. One method of producing it synthetically is by using L-sorbose as the starting compound and employing *sodium methoxide* in the final (enolization) step of the synthesis.

Index of Chemical Patents Now Being Prepared

Every patent relating to chemistry which has been issued by the U. S. Patent Office since 1950 is being collected and indexed for reference purposes by a Washington information service. The collection is being kept current and is being made available on a subscription basis to chemical companies, libraries, educational institutions and other interested organizations.

At the moment, indices for 1955, 1956, 1957 and the first 10 months of 1958 are available. They cover 30,000 patents. A trained staff of chemists and biochemists is now working on the indices for 1950-1954, which will add another 40,000 patents. It is estimated that when this work is completed, in about two and one-half years, more than 100,000 patents will have been collected and indexed.

It is claimed that the indexing method used analyzes, edits, classifies and cross-indexes U. S. chemical patents into the fastest and most accessible reference system ever devised.

CONTINUED *Alcohol*

brucine sulfate. Consequently, there are now three new SDA 40 formulations approved by the Alcohol and Tobacco Tax Division. U.S.I. designations are shown in the box below.

U.S.I. Designations for New SDA 40 Formulas

SD-40-1M .....1½ oz. brucine alkaloid
SD-40-2M .....1½ oz. brucine sulfate
SD-40-3 .....1½ oz. quassin

U.S.I. Studying Alternate Denaturants

Because brucine and quassin derive from natural imported products, there is always the possibility that the supply of these denaturants might be inadequate at some future date. U.S.I.'s research laboratories are therefore continuing studies to develop suitable additional alternates.

Ideally, alternate materials suitable as denaturants should be synthetic and domestically produced. Once found and tested in end-use formulations, such stand-by alternates—pending approval by the government—would assure denatured alcohol consumers of an uninterrupted flow of raw material at all times.

Methionine-Hormone Formulation Effective For Treating Acne

Clinical studies have revealed that a formulation of DL-acetyl methionine, estrogenic hormone, colloidal sulfur and resorcin applied to the skin is effective for treating acne conditions.

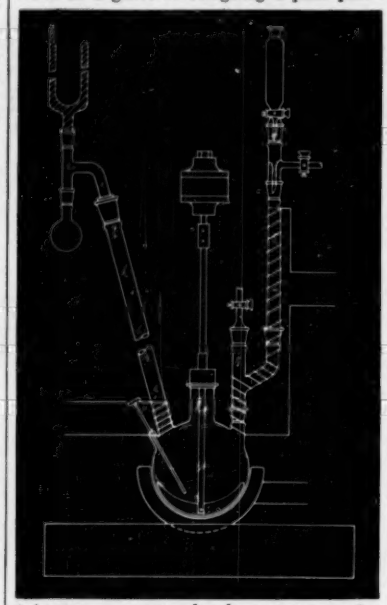
The medical research workers who conducted these studies found that methionine—the sulfur-bearing amino acid—and the estrogenic hormone act synergistically to reduce the excessive secretion of fatty materials from the sebaceous glands—a characteristic condition in acne cases. Consequently, the formulation dries and heals the acne lesions rapidly.

For optimum results, the treatment was supplemented with dietary and hygienic routines, and small oral doses of thyroid extract and estrogenic hormone.

Pure Sodium Alkoxides Can Be Made by Dry-Way Process

A new technical bulletin just released by U.S.I. describes a valuable but little-known technique for preparing sodium alkoxides from metallic sodium and alcohol vapors. This low-cost, dry-way process yields powders which are high-analysis alkoxide, in contrast to the 16-18% alkoxide solutions produced by the usual method of introducing sodium into liquid alcohols. It provides a way for pharmaceutical and other manufacturers who make their own alkoxides to get a high-purity material.

Products are almost identical in analysis to commercially available alkoxides. Although the bulletin describes the laboratory technique of passing vaporized alcohols over molten sodium, sufficient data is available to serve as a guide in designing a pilot plant.



Laboratory apparatus for dry-way preparation of sodium alkoxides.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

L-Methionine, labeled with both carbon-14 and deuterium (methyl-$C^{14}D_3$), can now be obtained for research purposes. This amino acid is reported useful in studying the mechanism of ergosterol. **No. 1430**

Cosmetic technology is discussed in new, 1450-page book now being sold. In 53 chapters, 61 experts cover over 3 dozen types of products. Includes technology, historic and legal aspects, physiology, testing, manufacture. **No. 1431**

Slide rule for chemists has special scales for solving pressure, temperature, solution concentration problems on one face, standard scales on other face. Gives atomic wts. of 52 elements, molecular wts. of 18 atomic groups. **No. 1432**

Chloromethoxypropyl mercuric acetate solutions now available in commercial quantity. Fungicidal and bactericidal activity claimed superior to phenyl mercuric compounds, due partly to presence of labile chlorine atom. **No. 1433**

Uses of stainless steel in CPI discussed in newly revised, 40-page free booklet. Sections on fields of plastics, detergents, nuclear power, others. Includes corrosion resistance table and table comparing stainless grades. **No. 1434**

Full line of polyesters for producing rigid or flexible urethane foams can now be obtained commercially. For rigid products, combinations of prepolymer and polyester are offered for foaming in place by mixing or spraying. **No. 1435**

Long-path infrared system recently developed is said to detect evaporation from one drop of a predetermined chemical in an average room. System senses the chemical by its IR spectrum, is not usually sensitive to other materials. **No. 1436**

Polyethylene work gloves now on market are claimed to provide protection without loss of fingertip sensitivity. Are lightweight, waterproof, resistant to most chemicals. Said to be suitable for use with radioactive materials. **No. 1437**

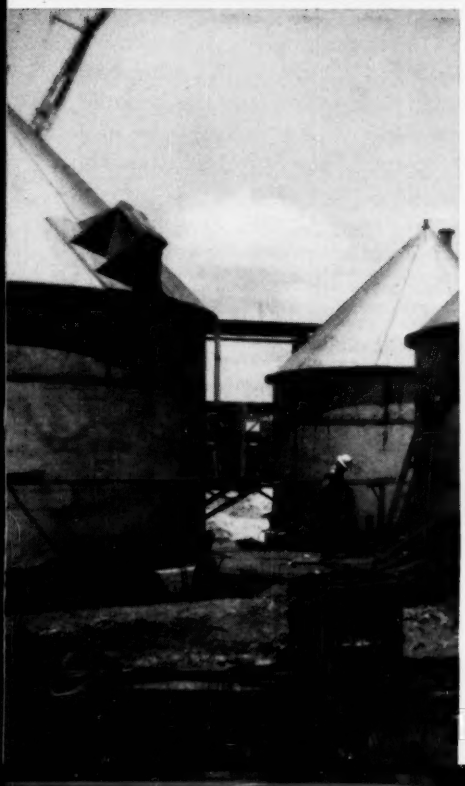
Comprehensive file of trademarks used by CPI here and abroad is now available for reference at a charge. Includes registered, unregistered, common, scientific, technological names. Composition, uses, producer given in many cases. **No. 1438**

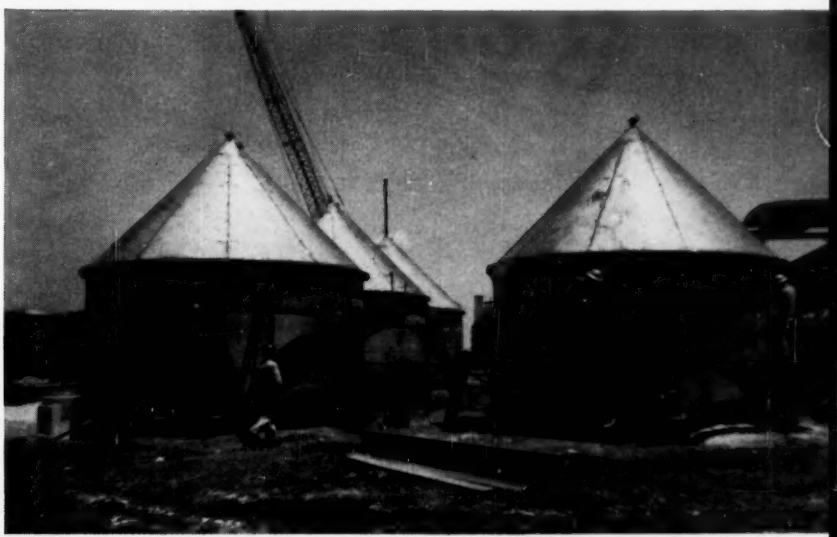
New analytical-grade ion-exchange resins based on cellulose are claimed suitable for chromatographic fractionations of high-molecular-weight materials beyond range of conventional resins. Are extremely porous and hydrophilic. **No. 1439**

Specially Designed In Stainless

TO ASSURE CLEANLINESS OF POLYETHYLENE RESIN PELLETS

At a new automatic high-density polyethylene plant, keeping resin pellets clean until mixed with water to form a slurry for movement through lines found solution in these stainless steel tanks. Fabricated from Type 304 stainless at one Graver plant and field-erected by a Graver crew from another, these specially designed tanks were readily handled by Graver's nation-wide facilities. May we show you how Graver's century of experience can be extremely helpful when you face storage or processing problems requiring fabrication and field-erection in alloys?



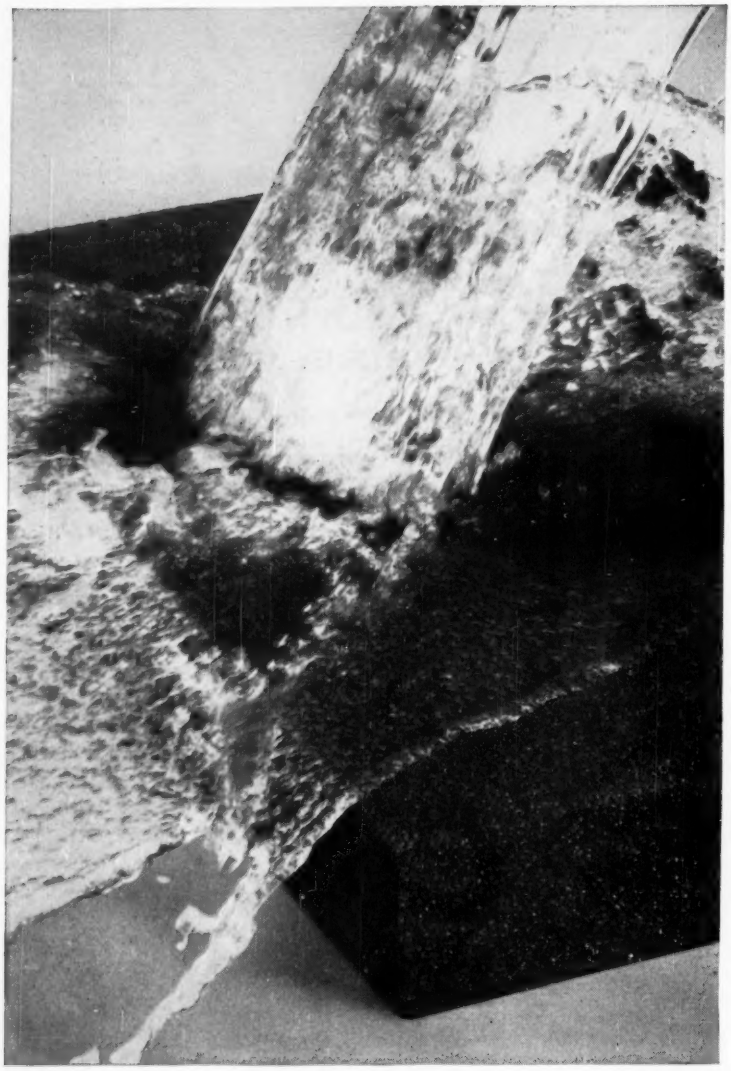


GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, IND.
Plants and Offices Across America

GRAVER®

Only cellular glass insulation

FOAMGLAS® IS THE ONLY



Whether you insulate building roofs and walls, piping or equipment, you can seldom anticipate *all* of the conditions to which your insulation will be exposed after installation. Humidity conditions change. Temperature control needs vary. Even the original use for insulated space or equipment may alter. That's why the ideal thermal insulation must give you a *combination* of key benefits . . . in order to serve satisfactorily under all possible conditions.

Most important, the ideal insulation must be impervious to water vapor as well as liquids—in order to insure constant performance under all humidity exposures. It should be proof against acids and acid vapors. It should be incombustible . . . dimensionally stable . . . impervious to vermin . . . strong enough for a variety of structural uses. Just one insulation—cellular glass—meets all of these qualifications.

FOAMGLAS is the only cellular glass insulation.

FOAMGLAS may well be the one satisfactory solution to all your insulating problems. For detailed literature, write—specifying your particular insulation requirements—to Pittsburgh Corning Corporation, Dept. H-19, One Gateway Center, Pittsburgh 22, Pennsylvania.

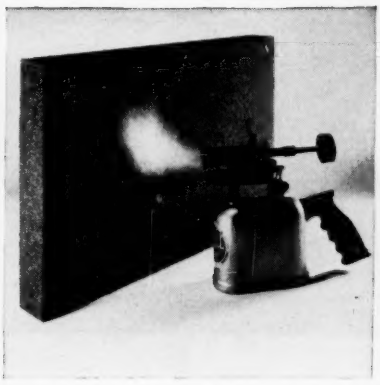
PC Glass Blocks and FOAMSIL® are other outstanding products of Pittsburgh Corning.

P I T T S B U R G H

gives you all these key benefits

CELLULAR GLASS INSULATION

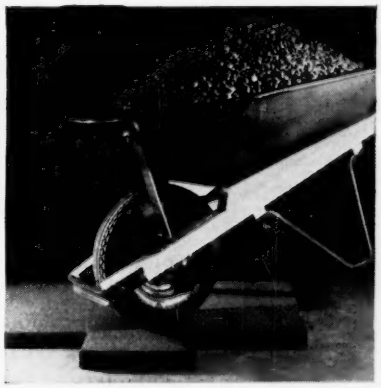
Moisture-proof! The minute liquid or vapor enters an insulation, it begins to lose its insulating value because moisture conducts heat. FOAMGLAS, a material composed entirely of sealed glass cells, is completely impervious to all moisture. Its K factor—measure of insulating performance—never varies.



Can't Burn! Smoldering insulation in walls or roof of a building is a deadly fire hazard, hard to detect, difficult to control once detected. FOAMGLAS eliminates this hazard because it is the only insulation composed entirely of incombustible glass. This may even mean lower fire insurance rates in some cases.

Dimensionally Stable! Most insulations tend to warp, swell, shrink or slump after they are installed. This causes open joints in the insulation . . . insulation voids that create a serious loss of efficiency. There is no such difficulty with FOAMGLAS. This all-glass insulation always maintains absolute dimensional stability.

Vermin-proof! Most insulations offer no protection at all against vermin in food processing, storage or handling operations. Rats and other vermin gnaw right through them. FOAMGLAS, on the other hand, affords an excellent vermin barrier. Its all-glass composition offers no food or nesting materials for vermin.

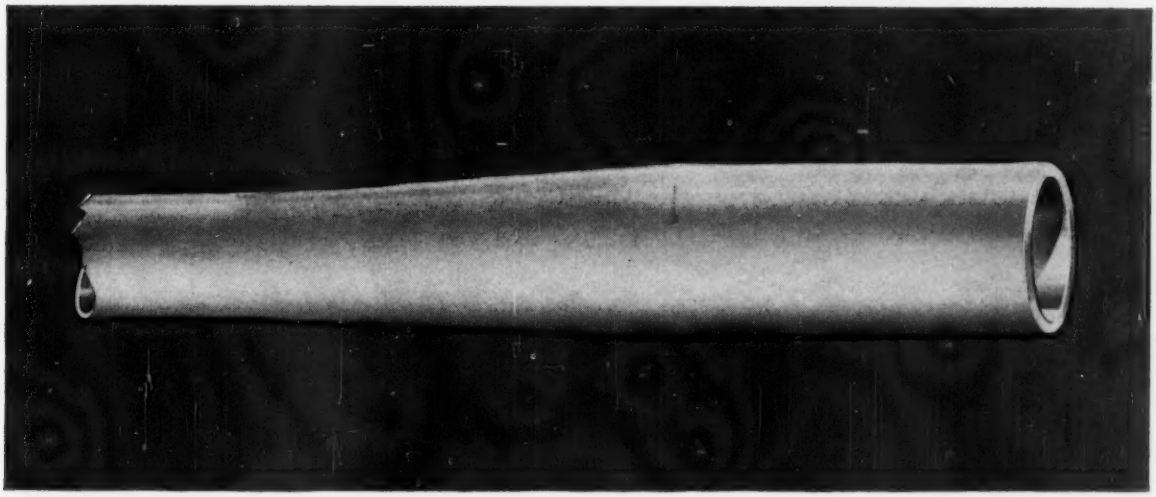


Strongest! FOAMGLAS has a compressive strength of over 7 tons per square foot (av. ult.). It forms a solid base for built-up roofing. It makes possible the placing of insulation beneath heavily loaded floors. And high strength FOAMGLAS permits such cost saving design innovations as free standing walls and partitions.

Acid-proof! There is often a lot of acid around a processing operation. Even the atmosphere around processing plants frequently has a high acid content. Acids will attack and destroy most thermal insulating materials, but they won't harm FOAMGLAS. This unique all-glass material is completely impervious to all common acids.

CORNING

Save up to 27% in piping costs!



HEAVY-END-PIPE®

... cuts weight... simplifies design... strengthens joints

REYNOLDS HEAVY-END-PIPE® DESIGN DATA

Schedule 80 Equivalent

Nominal Size	Major (Heavy End) O. D.	Major (Heavy End) Wall	Heavy End I. D.	Heavy(1) End Length	Minor Body O. D.	Minor Body Wall	Minor Body I. D.	Average(2) Weight Per Ft.
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Pounds
3	3.500	.300	2.900	10	3.150	.200	2.750	2.29
3½	4.000	.318	3.364	10	3.642	.214	3.214	2.84
4	4.500	.337	3.826	11	4.140	.232	3.676	3.57
5	5.563	.375	4.813	11	5.185	.261	4.663	4.98
6	6.625	.432	5.761	12	6.217	.303	5.611	6.95
8	8.625	.500	7.625	12	8.183	.354	7.475	10.68
10	10.750	.593	9.564	13	10.260	.423	9.414	15.65

(1) Length of heavy end wall thickness exclusive of transition zone
(2) Based on 40 ft. length

Schedule 40 Equivalent

Nominal Size	Major (Heavy End) O. D.	Major (Heavy End) Wall	Heavy End I. D.	Heavy(1) End Length	Minor Body O. D.	Minor Body Wall	Minor Body I. D.	Average(2) Weight Per Ft.
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Pounds
3	3.500	.216	3.068	10	3.214	.148	2.918	1.76
3½	4.000	.226	3.548	10	3.724	.163	3.398	2.22
4	4.500	.237	4.026	11	4.218	.171	3.876	2.64
5	5.563	.258	5.047	11	5.259	.181	4.897	3.53
6	6.625	.280	6.065	12	6.311	.198	5.915	4.66
8	8.625	.322	7.981	12	8.291	.230	7.831	7.12
10	10.750	.365	10.020	13	10.388	.259	9.870	10.16

(1) Length of heavy end wall thickness exclusive of transition zone
(2) Based on 40 ft. length

Nominal Size	6061-T6, 6062-T6 Alloy				6063-T6 Alloy			
	Ultimate Bursting Pressures	Working Pressures Factor of Safety 3	4	5	Ultimate Bursting Pressure	Working Pressures Factor of Safety 3	4	5
Inches	psi	psi	psi	psi	psi	psi	psi	psi
3	5150	1720	1290	1030	3680	1220	920	740
3½	4750	1580	1190	950	3400	1130	850	680
4	4460	1490	1110	890	3180	1060	790	640
5	3990	1330	1000	800	2850	950	710	570
6	3850	1280	960	770	2760	920	690	550
8	3410	1140	850	680	2430	810	610	490
10	3240	1080	810	650	2310	770	580	460

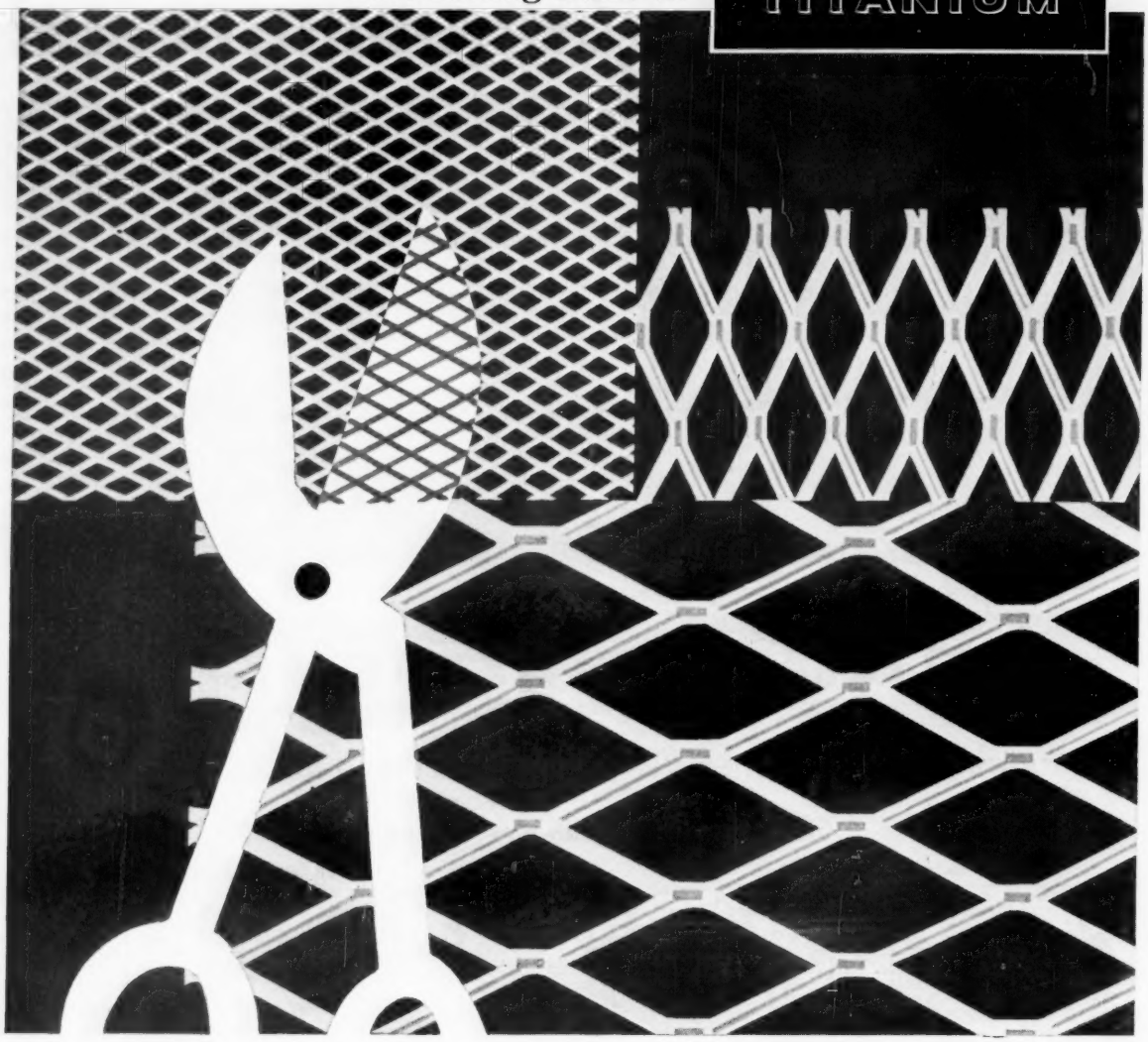
Nominal Size	6061-T6, 6062-T6 Alloy				6063-T6 Alloy			
	Ultimate Bursting Pressures	Working Pressures Factor of Safety 3	4	5	Ultimate Bursting Pressures	Working Pressures Factor of Safety 3	4	5
Inches	psi	psi	psi	psi	psi	psi	psi	psi
3	3640	1210	910	710	2600	860	650	520
3½	3450	1150	860	690	2365	790	590	470
4	3070	1020	760	610	2195	730	550	440
5	2690	890	670	540	1925	640	480	380
6	2450	810	610	490	1750	580	430	350
8	2160	720	540	430	1540	510	380	310
10	1950	650	480	390	1395	460	350	280

REYNOLDS ALUMINUM

Watch Reynolds new TV shows—"WALT DISNEY PRESENTS" and "ALL-STAR GOLF"—every week on ABC-TV.

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

Cost cutting ideas in **TITANIUM**



EXPANDED TITANIUM SHEET

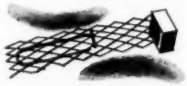
"opens up" new savings in corrosive plating applications

Now, cost-saving applications for titanium take another important step forward. Expanded titanium sheet, recently introduced by Mallory-Sharon, offers interesting possibilities for use in the plating and chemical processing industries.

Dip baskets

Filters

Its high corrosion resistance makes it ideal for use in acid plating, acid dipping baskets, and in protection shields for immersion heating electrodes. The new material is available in gauges from .015" to .125", from ⅛" to 1½" diamonds, and in standard 48" x 96" sheets.



Protective shields

Expanded titanium sheet is now available in production quantities. Prices vary with gauge and strand widths. For further information, write for Technical Data Sheet.

MALLORY SHARON

MALLORY-SHARON METALS CORPORATION · NILES, OHIO

SPROUT-WALDRON Pointers

for Mixing and Blending • Size Reduction
Size Classification • Bulk Materials Handling • Pelleting and Densifying

Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

BULK TRAILER FOR NEW JERSEY FLOUR MILLS

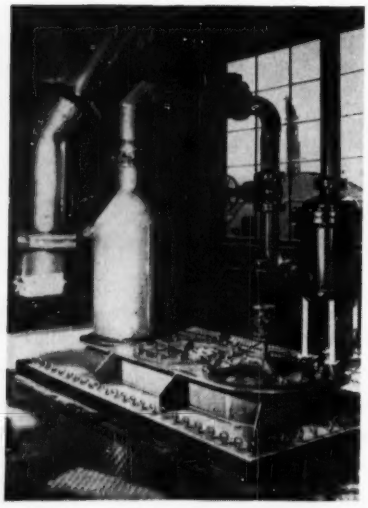
Delivery of a modern 1,225 cu. ft. capacity bulk body pneumatic flour handling trailer to New Jersey Flour Mills Company, Clifton, New Jersey highlights the trend to bulk handling in this industry.

The streamlined 28′ bulk truck body is of single compartment construction, having seven 24″x24″ inlet doors. Twin screw conveyors in the bottom of the body are driven through a positive infinite variable speed control unit. The system is self-contained and designed for efficient and economical loading and unloading at high speeds.

28′ Sprout-Waldron pneumatic bulk flour truck designed to speed local deliveries.

Lawrence F. Orbe, Jr., President of New Jersey Flour Mills Company, stated that, "bulk flour is better flour; not only from the standpoint of product cleanliness and good housekeeping, but in its improved baking qualities as well; a fact proved by leading cereal chemists. Economies to the baking industry through the use of bulk flour are also substantial. It is entirely possible that a savings of 30 to 40c/cwt. will develop through this modern method of loading out and transporting flour from mill to bakery."

SW



Adaptioneered Sprout-Waldron Horizontal Batch Mixer installed at The Dow Chemical Company, Midland, Michigan.

NICKEL MIXER FOR THERMOPLASTICS

The mixing of thermoplastic materials and formulations at The Dow Chemical Company, Midland, Michigan, requires the use of a special Sprout-Waldron Adaptioneered horizontal batch mixer. Two unusual design requirements stand out.

In the first place, all parts in contact with the material to be processed were specified in nickel, and in the second place the mixer had to be jacketed for 30 psi liquid working pressure.

The Sprout-Waldron special horizontal batch mixer used, has a swept volume capacity of approximately 58 cu. ft. and is designed to handle a 3000# batch of material weighing 50 lb. per cubic feet. Specifications also called for the mixer to have an extra heavy reinforced "U" trough and cover. The ASME code jacket was designed with internal baffles to prevent short circuiting and the box and cover of the unit were designed for 27″ of mercury vacuum inside.

Mixing is accomplished by means of a double ribbon agitator with the end stubs set in antifriction pillow blocks.

Prior to shipment, the mixer body was tested at 30 psig with atmospheric pressure in the jacket. The jacket itself was tested at 45 psig with atmospheric pressure in the shell.

CP/110

Fill your surfactant needs

from CARBIDE'S 9 TERGITOL nonionics

Take your choice from CARBIDE'S TERGITOL nonionics—one that is completely soluble in oil . . . another that dissolves in water at high temperatures . . . or one with a combination of characteristics. TERGITOL nonionics have outstanding capacity to emulsify oils, waxes, and greasy soils—to hold them in suspension. As wetting agents, TERGITOL nonionics are noted for their chemical stability in the presence of acids and salts. They are not affected by hard water or alkalies.

TERGITOL nonionics have proved effective in scouring, bleaching, and carbonizing compounds used by the textile industry. As detergents, they speed dishwashing, laundering, dry cleaning. They give good pigment dispersion, flow-out, and stability to latex paints. Metal cleaners, leather dressings, silicone preparations, shampoos, adhesives, bactericides—all can be improved with TERGITOL nonionics.

Cloud Points of 0.5% aqueous TERGITOL Nonionic Solutions (Degrees C.)

NP-14	Insoluble
NP-27	20
TP-9	51-56
NPX	60-65
NP-35	90-95
NP-40	100
TMN	35-37
XD	60-65
XH	90-100

You can obtain TERGITOL nonionics in 55-gal. drums, combination car load or truck load lots, or compartment tank car shipments. Your CARBIDE Technical Representative can help you solve your surfactant problems. Or write Dept. HC, Union Carbide Chemicals Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE CHEMICALS COMPANY

DIVISION OF UNION CARBIDE CORPORATION

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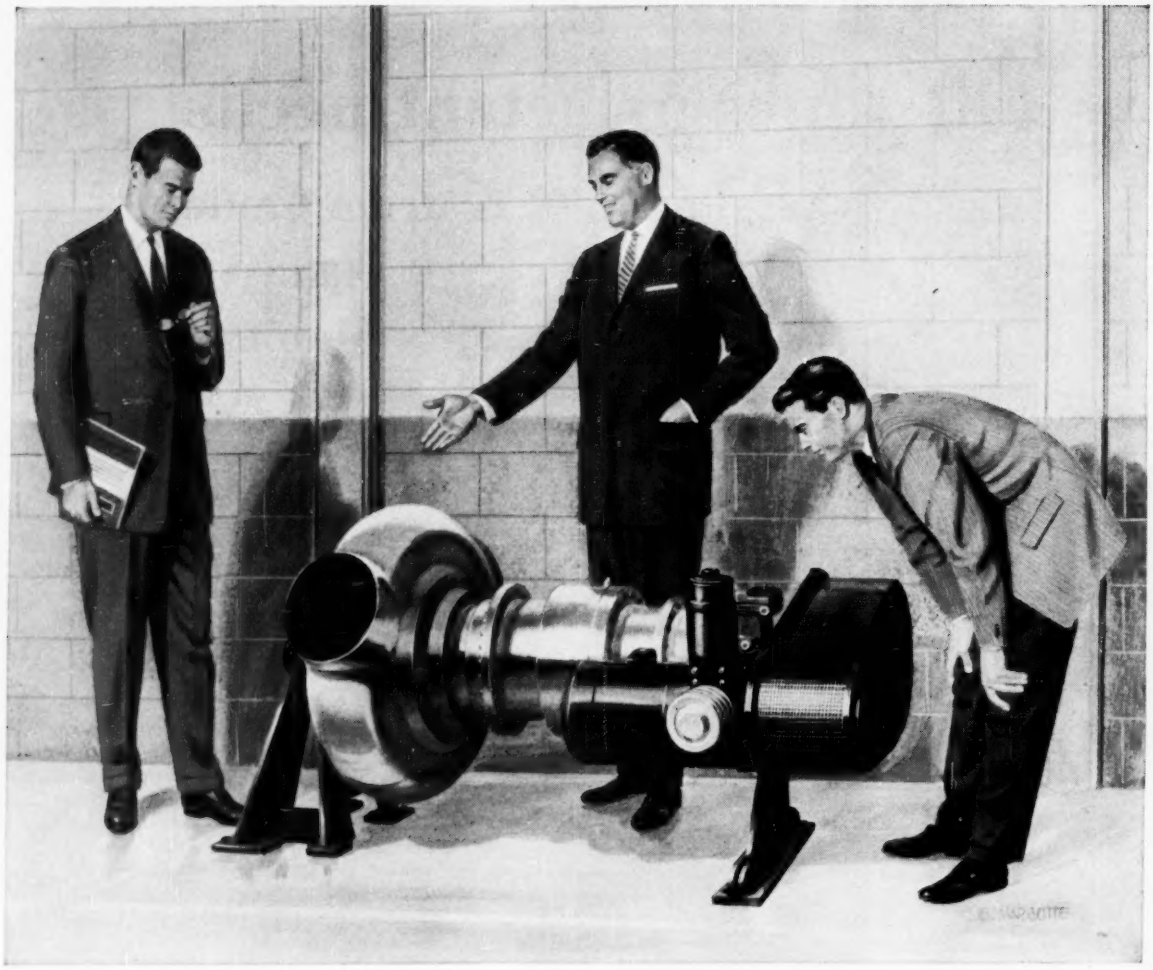


New 1100 hp Solar gas turbine offers small size, light weight, greater fuel efficiency

SOLAR'S NEW 1100 HP SATURN engine represents an important forward step in gas turbines. Advantages of the new power plant include these: it is extremely lightweight, averaging less than 1/10 the weight of conventional engines; it occupies only about 51 cubic feet; it starts instantly and takes full load without laboring in temperatures from −65F to 130F—even after long periods of standby service. In addition, the new Saturn engine offers an unequaled advance in gas turbine fuel efficiency, and it will operate on a great variety of fuels.

Today, proven-in-service Solar gas turbines—ranging from 50 to 500 hp—are creating new standards of performance and reliability. As propulsion units for speedy boats, as a power source for electric generators, as ground support units for advanced jet aircraft, as high-efficiency pumps and in other applications... Solar gas turbines are saving time and money for hundreds of satisfied users. Why not investigate the Solar family of gas turbines for *your* power needs? Write today to Dept. F-109, Solar Aircraft Company, San Diego 12, California.

CHARACTERISTICS OF THE SATURN GAS TURBINE

RATING	1100 hp (80F sea level)
WEIGHT	950 lb
OUTLINE DIMENSIONS (MAXIMUM)	
Length	69 in.
Width	45 in.
Height	44 in.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

ENGINEERS WANTED! *Challenging projects, unlimited opportunities with Solar. Write today!*

Blaw-Knox builds pace setting nitrogen plant for Columbia-Geneva Steel Division of U.S. Steel Corporation. This is the first U.S. installation in a major steel plant to use coke oven gas as the source of hydrogen for ammonia production. Located near Provo, Utah, the new plant includes administration, maintenance and compression buildings . . . ammonia synthesis, storage and shipping . . . nitric acid production, ammonium nitrate production, prilling, packaging and shipping.

U.S. STEEL MAKES NEW ADVANCE IN CHEMICAL OUTPUT

Anhydrous ammonia, oxygen, sulfuric acid, nitric acid, ammonium nitrate solids and solutions . . .

A world wide effort: From Italy, Montecatini provided processes for gas purification, ammonia synthesis and nitric acid production. From Germany, the German-Linde Company supplied low temperature air and gas separation units . . . and, for the first time in this country, the famous Lurgi process is used for sulfuric acid production.

Blaw-Knox Company, Chemical Plants Division with headquarters in Pittsburgh. Branch offices in New York, Chicago, Haddon Heights, New Jersey, Birmingham, Washington, D. C., and San Francisco.

for plants of distinction . . .

BLAW-KNOX

LUMMUS TO ENGINEER AND CONSTRUCT POLYVINYL ALCOHOL RESIN PLANT FOR AIR REDUCTION

Multi-million dollar Plant will Produce 20 Million lbs. Per Year of Polyvinyl Alcohol Resin

Air Reduction has selected Lummus to engineer and construct a new 20-million pound per year polyvinyl alcohol resin plant. It will be built on the 2,000 acres assembled by Airco at Calvert City, Kentucky, where the company has five other plants in operation.

The project, which is scheduled to go on stream by 1960, will include an expansion doubling the existing 45-million pounds per year vinyl acetate monomer plant, originally engineered and constructed by Lummus in 1956.

The new plant, based on a manufacturing process licensed by Air Reduction from Kurashiki Rayon Co., Ltd., of Osaka, Japan, will consist of three process sections – the polymerization section, the saponification section, and the acetic acid recovery section.

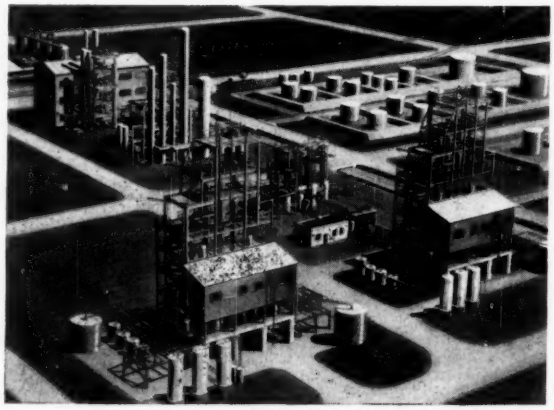
In addition to the polyvinyl alcohol resin plant, Lummus will build a number of additions and improvements for the existing chemical facilities, including: office, laboratory and service buildings; a fire-fighting system; electrical distribution; steam generation facilities; and truck and rail facilities. All of these units and the polyvinyl alcohol resin plant will cost approximately $12,000,000.

Construction of the new Calvert City plant, which will be operated by the Air Reduction Chemical Company division, was started this summer.

Existing uses for polyvinyl alcohol in this country are in the preparation of adhesives, textile sizing, paper coatings, and as emulsifying and thickening agents. A special form is also used as a starting material in the production of polyvinyl butyral, which is the plastic interlayer for automobile safety glass.

The expansion for vinyl acetate monomer is directly related to the polyvinyl alcohol plant in that approximately two pounds of vinyl acetate monomer are required to make one pound of polyvinyl alcohol resin.

For any type of chemical or petrochemical plant, Lummus' half century of world-wide experience is at your disposal.



Artist's conception of Air Reduction's expanded facilities at Calvert City. In the background is the polyvinyl alcohol resin plant. In left foreground is the new vinyl acetate monomer plant. To the right is the original vinyl acetate monomer plant.

NEW Allis-Chalmers 2,000-lb Lift Truck ...a Standout Performer!

LET'S LOOK AT THE FACTS...

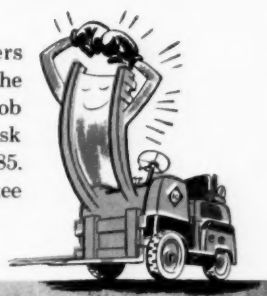
Greater Lugability— from a rugged heavy-duty industrial engine with full 35 hp, 97 ft-lb of torque.

Climbs a 40-percent ramp loaded. Power, traction, plus low center of gravity, add up to gradability that can't be matched.

Greater accessibility— ready for servicing in 22 seconds . . . and can be stripped down to the chassis in 22 minutes. Serviceability like this means many extra hours on the job.

Proven "Years-Ahead" design—means *more* dependable, continuous . . . economical hours on the job.

Ask your Allis-Chalmers dealer to demonstrate the NEW FT20-24 on *your* job under *your* conditions. Ask for the new Bulletin BU-485. Allis-Chalmers, Milwaukee 1, Wisconsin.

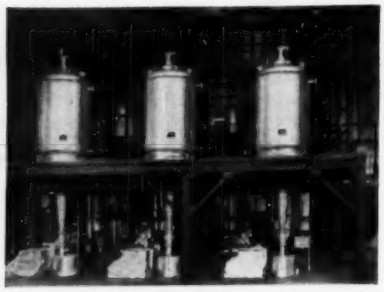


BH-82

ALLIS-CHALMERS

"Hefty" the FT 2,000-lb champ Saves you more, Makes you more.

QUALITY PARAFFIN IS PRODUCED AT A FRACTION OF A CENT PER POUND



Top quality, clear and odorless paraffin is produced continuously at a fraction of a cent per pound at the Trans Penn Wax Corporation in Titusville, Pennsylvania. To attain this paraffin purity, three Rodney Hunt Vacu-Film Processors are used. In this liquid process, as in many others, it has proven to be less expensive to increase the vacuum than the temperature.

Vacu-Film Processor

HIGH VACUUM PROCESSING

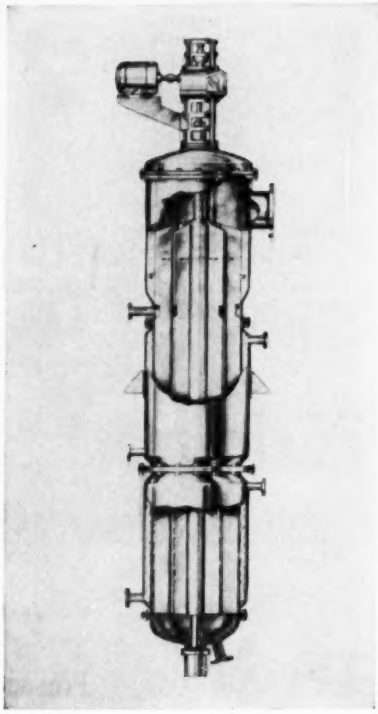
The Vacu-Film Processor has an alloy steel shell enclosing the rotor, shaft with wiper assembly, oil diffusion pump, oil seal, vertical condenser and entrainment separator. The alloy steel condenser is finned for efficient heat transfer and is water-cooled or refrigerated with circulating cooling fluid. Distillate and residue are separately discharged by oil-sealed positive pressure pumps. High vacuum is produced by conventional series coupling of high-speed gas ballast mechanical pumps and oil diffusion and oil ejector pumps.

IMPROVED QUALITY CONTROL ASSURED WITH RODNEY HUNT THIN-FILM TECHNIQUE

In one pass... continuously and rapidly... Rodney Hunt thin-film processing equipment achieves quality control of viscous fluids hitherto unobtainable by any other means. Only relatively small amounts of product are in process at any given moment. Therefore, the condition of the product can be checked continuously and controlled instantly to eliminate production errors and wasteful re-runs of reject material. This close control is particularly vital in the processing of delicate and temperature-sensitive materials. And this technique is especially effective in controlling the behavior of organic materials in high vacuum.

The Rodney Hunt Turba-Film Processor has wide applications in atmospheric and low vacuum ranges. The recently introduced Vacu-Film Processor extends the range of thin-film processing into high vacuum... to one-half micron. Installations presently in operation have delivered higher, purer yields than ever before possible in processing organic and inorganic chemicals, pharmaceuticals, latices, petroleum residues, solvents, food concentrates, vitamins and many other products.

Turba-Film Processor



MECHANICALLY AIDED THERMAL PROCESSING

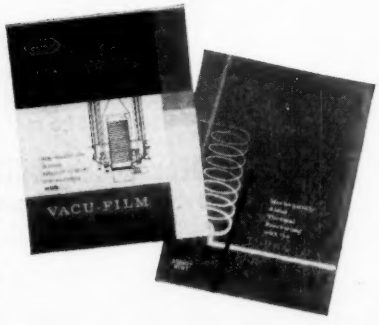
The Turba-Film Processor consists of a series of rotor blades operating within a thermal section and a separating section—all fabricated of alloy steel. Clearance between the rotor blade edges and the thermal section wall is exactly fixed to assure precise control of the film thickness. Vapor or gases pass upward through the thermal section to the separator from which entrained material is recycled to the thermal section. Steam, Dowtherm or other heating media is distributed in two or more compartments of the thermal section to assure a uniform temperature at the walls.

Solve Process Problems

Rodney Hunt welcomes specific requests for help in solving process problems involving mechanically aided heat and mass transfer, for product testing and for evaluation of processing techniques. Our fully equipped laboratory and pilot plant is staffed by engineers and technicians experienced in food, chemical, plastic and many other processing fields. They have tested hundreds of products in the laboratory and have compiled extensive records which provide basic data to expedite testing of new products. Customers may observe testing procedures and will receive complete reports. Test results obtained from pilot size Vacu-Film and Turba-Film Processors can be readily extrapolated to production size units.

For those who prefer to do their own testing, portable laboratory and pilot plant units are available for purchase or rental. Address your inquiry to the Rodney Hunt Process Equipment Division, 31 Vale Street, Orange, Mass. with details of your requirements. Literature on the Turba-Film Processor and the Laboratory Vacu-Film will be sent on request.

* * *



DEVELOPMENTS . . .

JANUARY 26, 1959

Chementator

C. H. CHILTON

New high in data-handling capacity is embodied in two 700-channel Beckman systems bought by Du Pont for its Belle (W. Va.) plant. One is now at work on an adipic acid unit; the other will help operate a revamped ammonia plant.

American Chemical Corp., jointly owned by Stauffer and Richfield Oil, will make ethyl chloride, ethylene dichloride and vinyl chloride in a new $7.5-million plant being built at Watson, Calif., adjacent to a Richfield refinery. Output will supply Western markets.

Know a good potential use for levulinic acid? You can win up to $5,000. That's top prize (there are 103 other cash awards) in Quaker Oats' $10,000 contest aimed at boosting commercial stature of its newly developed product. Contest closes March 1.

New way to make anhydrous caustic

Dow Chemical has developed a new technique for continuous finishing of caustic soda. Pilot-planted at Freeport, Tex., for the past year, the new process is slated for commercial use at Freeport and, apparently, at Dow's Midland, Mich., plant too.

Company officials refuse to discuss technology of the process. This secrecy assuredly implies a major departure from use of Dowtherm-heated, long-tube, vertical evaporators —practiced since 1946 at Dow's Pittsburg, Calif., plant and employed also by Diamond, Columbia-Southern and other caustic producers (Badger and Standiford, *Chem. Eng.*, Feb. 1954, pp. 183-187).

Unofficially, *CE* has learned that the new process substitutes direct firing for Dowtherm heating—a significant switch for the maker of Dowtherm. Previous deterrent to direct firing has been danger of overheating in event of tube plugging. This drawback has evidently been overcome with a reliable control or warning device.

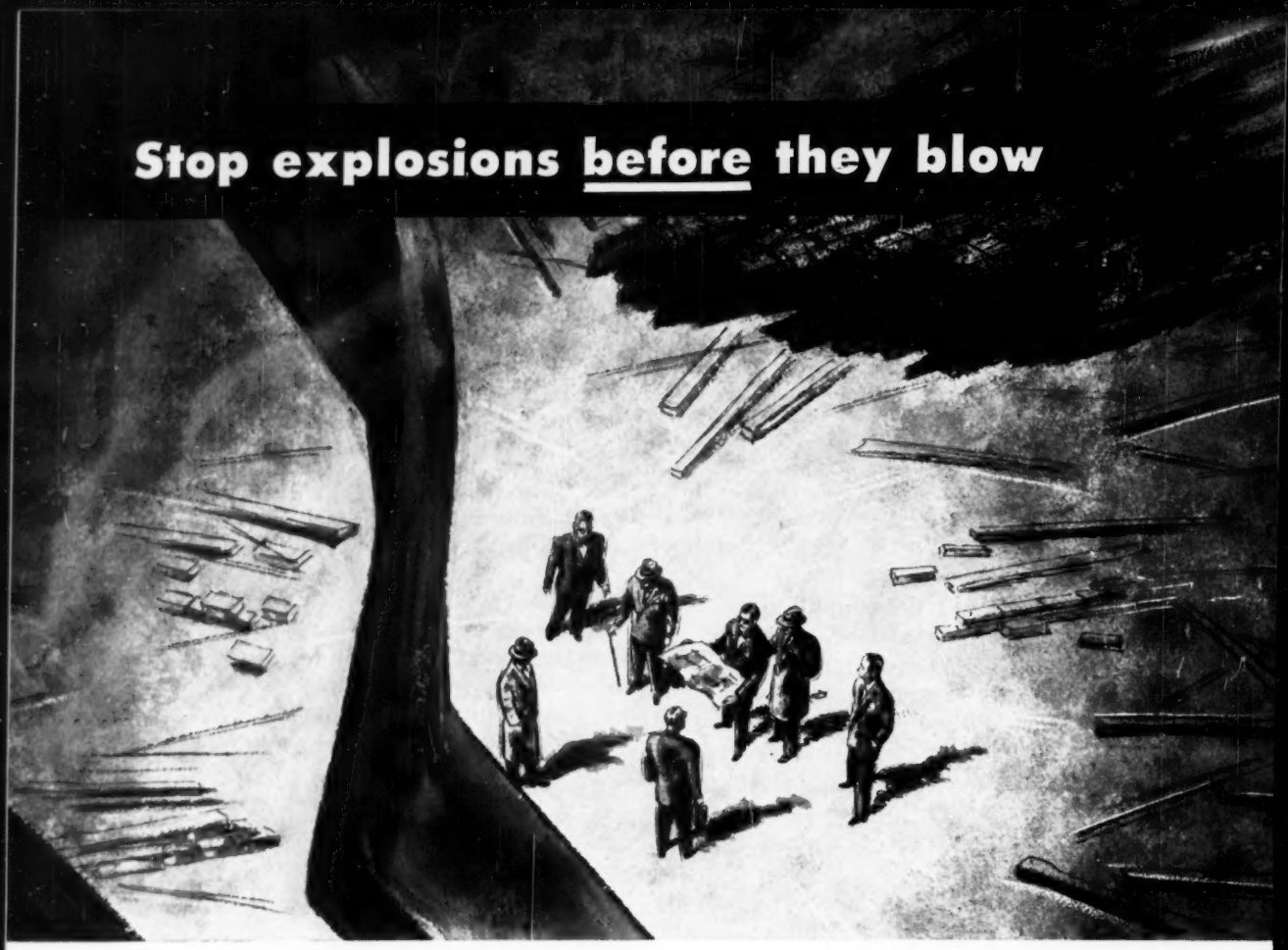
Why the switch from Dowtherm? Eliminating the Dowtherm boiler will, of course, represent a definite savings in investment. So will elimination of shell-and-tube calandria construction, with its attendant thermal-expansion problems. Another reason is suggested in the Badger-Standiford article: To get top caustic quality with Dowtherm heating requires temperature levels over 700 F., where thermal decomposition of Dowtherm begins to assume serious proportions.

Chemical makers eye solid oxidizer

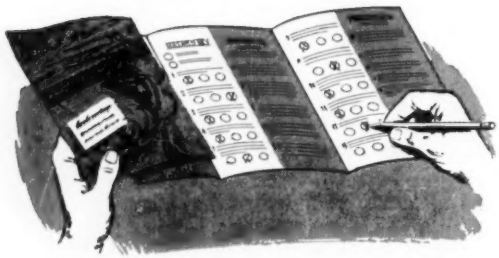
While commercial production of lithium perchlorate—a promising oxidizer for solids-fueled rockets—is still a thing of the future, right now there's a lot of jockeying for position at the starting gate. For example:

• HEF, Inc.'s new 4-million-lb./yr. ammonium perchlorate plant at Columbus, Miss. —due for startup this month—is designed for

Stop explosions before they blow



Send for the CROUSE-HINDS "Hazard Finder"



● The Hazard Finder will enable you to make a quick survey of the hidden probabilities of electrically-ignited explosions in your plant.

Let Crouse-Hinds equipment and technical assistance help you to prevent electrically-ignited explosions.

The more than 15,000 Condulet ® items in the Crouse-Hinds line, include the world's widest selection of explosion-proof and dust-tight electrical equipment. There are Condulet devices for every circuitry requirement, and for every hazardous area and condition. All backed by engineers and technicians thoroughly familiar with Article 500 of the National Electrical Code and its application to specific situations.

For a quick, general survey of probable dangers in your plant, send for the Hazard Finder. For technical discussion of specific areas and hazards, write for Crouse-Hinds bulletins which apply.

● Or for personal assistance, ask any of the offices listed below to send a Field Engineer.

FREE

CROUSE-HINDS CO.
Syracuse 1, N. Y.

I want to check my plant. Send me your Hazard Finder.

Name_____

Company_____ Title_____

Address_____

City_____ State_____

CROUSE HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

● CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) ● FLOODLIGHTING
● TRAFFIC CONTROL SYSTEMS ● AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington **Resident Representatives:** Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport

easy conversion to lithium perchlorate manufacture. HEF describes this plant as "the nation's only plant capable of producing lithium perchlorate commercially," stressing the basic importance of its dual function. A joint venture of Hooker Chemical and Foote Mineral, HEF has a good basic materials position in Hooker's sodium chlorate production and Foote's lithium operations.

• American Potash tells *CE* that for more than two years it has been making lithium perchlorate in developmental quantities at Trona, Calif., "can readily produce this material in commercial quantities" and will do so when and if the market opens up. American Potash has been producing lithium carbonate from Searles Lake crude lithium concentrates at Trona since 1951 (*Chem. Eng.*, Sept. 1953, pp. 144-150). The company also began making ammonium perchlorate in 1953 in a $5-million, 40-ton/day plant at Henderson, Nev.; a *CE* editor preparing a Process Flowsheet (Dec. 1955, pp. 334-337) was first outsider to see this Navy-financed facility.

• Lithium Corp. of America, also scrutinizing the perchlorate picture, is putting into pilot plant this month what is said to be a new process independent of purchased sodium perchlorate. LCA has decided that an older process, piloted last year, is uneconomical. The company is now negotiating with an unidentified prospective partner who has been researching a lithium perchlorate process similar to LCA's. If these negotiations fall down, LCA is willing to go it alone.

Rolling with the punch cuts power costs

Substitution of curling or rolling action for brute force is key to low power consumption of a new continuous process for producing mechanical pulp from hardwoods.

New process, being offered by Black-Clawson Co., New York, has just emerged from commercial-scale tests in the company's pilot pulp mill at Berlin, N. H. It entails softening of hardwood chips by cold caustic soda solution, followed by fiberizing in a vertical-disk attrition mill.

This flowsheet isn't unique; there are several mills in the U. S. using such a scheme (*Chem. Eng.*, Nov. 1956, pp. 134-136). But their reported power requirements range upwards from 30 hp./daily ton. Black-Clawson claims power consumption as low as 10 hp./daily ton.

B-C ascribes to its new disk mill—called the Chemifiner—a large share of the credit. Other commercially available chip-fiberizing machines use a pair of opposing vertical disks mounted in line; they either rotate in opposite directions, or one rotates while the other remains stationary. In the Chemifiner, both disks rotate in the same direction, but the axes of rotation are vertically displaced by an adjustable distance. Result: An adjustable relative surface speed of 100-250 ft./min., a curling or rolling action on the softened chips and a powerful defibering ability without loss in freeness or fiber length.

Prior to Chemifining, chips sprayed with white liquor go through a screw press, are released to be immersed for 20 min. in a continuous screw-conveyor reactor and are again screw-pressed. Following the Chemifiner are a Sutherland disk refiner, screens and filter washers.

Cold soda pulping was first developed in the early 1950's by Forest Products Laboratory, Madison, Wis. In its original form, impregnation involved a 2-hr. soak which discolored the pulp. Today's commercial versions include the pressing action during impregnation, shortening this step to 30 min. or less.

Grinding under liquid speeds reaction

Faster digestion of bauxite and higher yields of alumina are possible by mechanically mulling or grinding the bauxite while it is being digested in the usual Bayer process.

Such is the claim of Gebrueder Giulini GmbH., German alumina producer. The company has tested this technique thoroughly, plans to put it into large-scale practice soon (Giulini sells about 100,000 tons/yr. of alumina).

Conventional digesters can be modified to use the new system. The electrically driven grinding mechanism consists of "a pair of steel runners shaped like plane tires which are mounted to an axle and run along a cavity in the autoclave bottom." A special bottom piece is welded to the bottom of the original digester. The runners are pressed to the bottom by means of a coil spring.

Savings depend on nature of the bauxite being processed. With soft bauxite, there is no increase in yield, but batch time is 1 to 2 hr. shorter. With hard bauxite, the grinding-

(Continued on page 40)

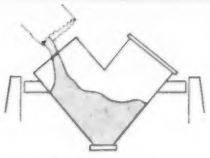
ENTIRELY NEW PRINCIPLE enables you to . . .

Blend

liquids and solids intimately in one operation

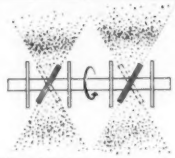
It is now practical, with the P-K "Twin-Shell"* blender, to blend many difficult formulations that have heretofore been either impossible or impractical because of the number of separate operations required to achieve a desired product. With the new "Twin-Shell" blender, liquids, solids, clumpy and crystalline materials can all be intimately blended in one operation. Average blending time: 5 to 15 minutes. The P-K "Twin-Shell" blender is unlike any other blender. It works on an entirely new blending principle. Here, in diagram, is how it works.

*Patented

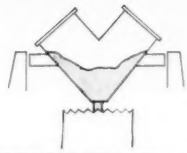


CHARGE DRY SOLIDS through top of either shell. Optimum charge level for most materials is about 65% of total shell volume.

TUMBLE AND AERATE. As shell revolves, rapidly spinning wire cage intensifier breaks up agglomerates, literally creates dust storm in material.



ADD LIQUID. Centrifugal force sprays atomized liquids from periphery of control discs on Liquid-Feed Bar into finely dispersed solids.



DISCHARGE PRODUCT easily through apex of shells. Accessibility of interior and easy removal of Liquid-Feed Bar speed cleaning.

Get new ideas for your blending process at P-K's pre-test lab

Complete, scientific investigation of all types of blenders now available at Patterson-Kelley.

Blending of complex formulations is full of variables. The equipment and procedure that are ideal for one combination of ingredients may be unsatisfactory for another. Proper selection of equipment demands thorough scientific investigation. You can conduct your investigation at Patterson-Kelley's Customer Pre-Test Lab, at East Stroudsburg, Pennsylvania. Since P-K makes practically all types of blenders, you can run conclusive comparison tests with your materials. Trained technicians will help you.

To set up an appointment, just place a collect call to Russell Dotter at Patterson-Kelley. Tel. No.: Stroudsburg 820. He'll be happy to tell you how much of your materials to bring and to give you other details. East Stroudsburg, in the Pocono Mountains, is just 2 hours from New York City, easily accessible by all carriers.

digestion gives better yields (about 7%) without saving any time.

Another advantage claimed by Giulini is that the ratio of caustic to alumina (Na_2O: Al_2O_3) can be reduced from the usual 1.8-1.9 to 1.3. This means that consumption of process steam is appreciably lowered.

Robot monitor moves onward, upward

Westinghouse's Opcon optimizing controller, whose principles were first described by Mathematician Robert Hooke in this magazine (June 1957, pp. 284-286), will soon make its debut in control of a commercial chemical process operation.

Sun Oil Co. plans to install an Opcon system, now being built, on a benzene-toluene-xylene fractionator at Marcus Hook, Pa. Opcon will automatically control the distillation operation to get maximum dollar profit.

Only other production use of Opcon has been by Westinghouse itself, in manufacture of capacitors at Bloomington, Ind. But Dow Chemical, who has employed an Opcon in a "miniplant" to find optimum operating conditions for ethyl benzene dehydrogenation, anticipates Opcon operation of full-scale styrene production.

Opcon's approach to process control is much like tuning an AM radio to get the strongest signal. Opcon experimentally (and continually) juggles the input variables, notes their effects on the desired output variable and quickly corrects any wrong moves to maximize the desired output. Unlike process simulation by digital computer, the uncanny Opcon does not need to know the usually complicated (and often imperfectly known) mathematical relationships of process variables. And its cost (on the order of $25,000) is only a small fraction of the cost of computer-controlled systems.

For its development of Opcon, Westinghouse won the 1958 Industrial Science Achievement Award of the American Assn. for the Advancement of Science. Award was made at AAAS's Washington meeting on Dec. 29.

Fluorination recovers spent uranium

First nonaqueous system for reprocessing spent nuclear fuels to achieve pilot-plant success is the fluoride volatility process. Both Argonne and Oak Ridge National Laboratories have recently reported definite progress in their related but dissimilar attacks on the high costs of present aqueous reprocessing methods.

Idea common to both efforts is conversion of uranium content in spent fuel into the volatile uranium hexafluoride. Just how this is done depends on such factors as physical form of the spent fuel, as well as choice of fluorinating agent and other variables.

Oak Ridge has piloted a process for reprocessing a homogeneous molten-salt aircraft-reactor fuel consisting of NaF, ZrF_4 and UF_4. Capitalizing on availability of and experience with elemental fluorine, ORNL bubbles the gas through the molten salt at a temperature above its 525 C. melting point.

Argonne, on the other hand, uses bromine trifluoride as reagent to fluorinate the metallic uranium content of heterogeneous fuel elements. Reaction conditions of 120 C. and 3 atm. pressure form UF_6 directly. ANL says that this process is applicable to certain types of homogeneous fuels, such as the uranium-bismuth fuel of a liquid-metal-fueled reactor. But to handle fuels high in zirconium content, ANL's approach is similar to ORNL's. The metals are dissolved in molten fluoride salt by sparging with HF at about 600 C.; then the UF_4 is fluorinated to UF_6.

Both groups are running bench-scale units for plutonium recovery via the volatile PuF_6. Encouraging results at Argonne indicate that the scheme will be stepped up toward pilot-plant investigations.

How to pamper heat-sensitive liquids

Latest twist in falling-film evaporators: A series of spinning disks which redistribute descending liquid evenly over a heated surface.

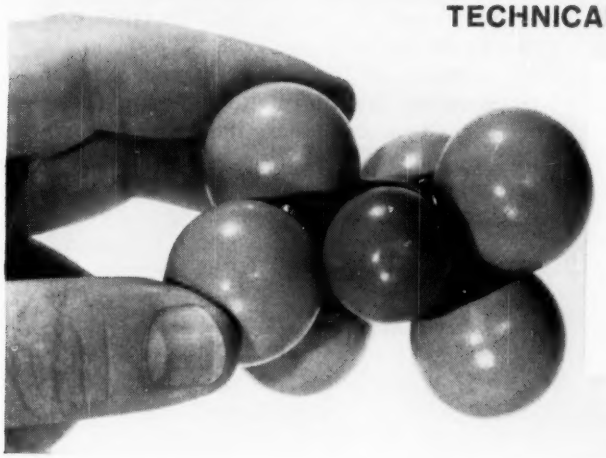
This is the novel feature of the new Stora-Vulcan evaporator, designed and built by Vulcan-Cincinnati working with the Swedish firm, Stora-Kopparbergs. New unit is claimed to cut capital investment and utility costs while giving quick, gentle evaporation of heat-sensitive liquids.

Interior of the evaporator is a stack of compartments shaped like truncated cones with their wide ends up. Liquid flows evenly down the sloping wall of one compartment and drops out of the smaller end onto a spinning disk just below. The disk flings the liquid by centrifugal force against the wall at the top of the next chamber. A heating jacket surrounds the entire stack of compartments.

Stora-Vulcan evaporators are now being

HEXACHLOROACETONE $(CCl_3)_2CO$

TECHNICAL, 97%



Hexachloroacetone is a strongly ketonic, non-flammable chemical intermediate and solvent. Structure and properties of its derivatives suggest their application as pharmaceuticals, herbicides, fungicides and insecticides. Derivatives include alcohols, amides, acids, acid chlorides and chlorofluoro compounds such as chlorofluoro-acetic acids, -acetic anhydrides, -acetyl chlorides, -acetamides, -acetones, and -ketone complexes.

Which of these interesting reactions interests you?

Hexachloroacetone reacts very slowly with water to yield trichloroacetic acid and chloroform.

$$Cl_3C\cdot CO\cdot CCl_3 + H_2O \longrightarrow Cl_3CCOOH + CHCl_3$$

Hydrolyzes very rapidly with aqueous bases yielding sodium trichloroacetate and chloroform.

$$Cl_3C\cdot CO\cdot CCl_3 + NaOH \longrightarrow Cl_3C\cdot COONa + CHCl_3$$

Amines and ammonia yield amides of trichloroacetate and chloroform.

$$Cl_3C\cdot CO\cdot CCl_3 + NH_3 \longrightarrow Cl_3C\cdot CO\cdot NH_2 + CHCl_3$$

$$Cl_3C\cdot CO\cdot CCl_3 + (CH_3)_2NH \rightarrow Cl_3C\cdot CO\cdot N(CH_3)_2 + CHCl_3$$

Hexachloroacetone reacted with aniline yields trichloroacetanilide and chloroform.

$$Cl_3C\cdot CO\cdot CCl_3 + C_6H_7N \rightarrow Cl_3C\cdot CO\cdot NHC_6H_5 + CHCl_3$$

Heating of one molecular proportion of urea with two molecular proportions of hexachloroacetone, the amide is readily obtained.

$$OC\begin{matrix}NH_2\\NH_2\end{matrix} + 2Cl_3CCOCCl_3 \longrightarrow CO(NHCOCCl_3)_2 + 2CHCl_3$$

Reduction with lithium aluminum hydride produces hexachloroisopropyl alcohol.

$$Cl_3C\cdot CO\cdot CCl_3 + \xrightarrow[LiAlH_4]{2H} Cl_3CHOHCCl_3$$

Chlorinolysis of hexachloroacetone produces trichloroacetyl chloride and tetrachlorethylene or carbon tetrachloride and tetrachlorethylene.

$$Cl_3C\cdot CO\cdot CCl_3 + Cl_2 \longrightarrow Cl_3CCOCl + Cl_2C = CCl_2$$

$$Cl_3C\cdot CO\cdot CCl_3 + Cl_2 \longrightarrow CCl_4 + CO + Cl_2C = CCl_2$$

Reaction with hydrogen fluoride in presence of a catalyst yields chlorofluoroacetones.

$$Cl_3C\cdot CO\cdot CCl_3 + 4HF \longrightarrow CClF_2\cdot CO\cdot CClF_2 + 4HCl$$

Like to experiment with HCA? Write us on business letterhead for experimental quantity. Hexachloroacetone is commercially available in 5 and 55 gallon drums, and in tank cars. Mail coupon for Product Information Data Sheet.

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☐ Please send Product Information Data Sheet on Hexachloroacetone (DA-37501)
☐ Please send sample. Business letterhead is attached.

Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State_____

CE-19

installed in urea plants in Korea and Formosa which use the Vulcan-Inventa process (see pp. 78-81). Function is to concentrate aqueous urea solution from around 80% to over 99.5%, prior to prilling. Heat sensitivity makes this a natural application for thin-film evaporators.

First Stora-Vulcan installation in the U. S. was at an unnamed urea plant (presumed by trade sources to be Sohio at Lima, Ohio). This machine was later removed and is now used by Vulcan as a pilot unit for further development and exploration of applications to tall oil, pharmaceutical and foodstuff processing.

Tomorrow's Technology

Today's embryonic developments which have special significance for chemical engineers

Polystyrene fiber makes novel filter

Spraying a 10% solution of polystyrene in methylene chloride onto a backing of Dacron mesh produces a high-efficiency filter mat which will aid in analysis of the upper atmosphere for radioactive particles. Stanford Research Institute developed the new technique for the Air Force.

This completely organic filter mat, says SRI, retains 99.5% of the particles it picks up, down to 0.01 micron. The filter can be readily burned away, or "ashed," leaving only radioactive residue for analysis.

When the polystyrene solution is sprayed onto the Dacron mesh (a 50-psi. air pressure provides the best spray rate), the solvent evaporates rapidly, leaving thin fibers less than 1 micron thick and 1 in. long. The resulting mat is rolled under pressure to improve cohesion and strength.

Dust-fueled reactor seeks an angel

Intensely disappointed at impending termination next month of AEC's research support of the Armour dust-fueled reactor (ADFR), Armour Research Foundation, Chicago, is vigorously campaigning to find an industrial sponsor for the project.

Armour engineers are convinced that the ADFR represents the most elegant reactor concept for economic nuclear power. It has the advantages of a fluid-fuel system without materials and corrosion problems; it permits a compact installation; it affords high reactor temperatures for good heat-transfer and energy efficiencies.

Concept of the ADFR is analogous in flowsheet to the LMFR (liquid-metal-fueled reactor, *Chem. Eng.*, Mar. 1956, pp. 114-115). Fuel would be low-cost, finely divided uranium carbide or dioxide, carrier gas would be helium or carbon dioxide. Reactor core can be simply a block of ceramic moderator material (graphite or beryllium oxide) pierced with holes for passage of the fuel-laden gas. No control rods are needed.

Fuel and gas would be continuously circulated by a blower through reactor core and a steam boiler at a temperature level of some 2,000-3,000 F. Alternatively, the hot gas stream could be used to furnish heat for an endothermic chemical process.

During the past year, Armour has conducted small-scale loop tests, as well as carried out criticality calculations for a series of possible ADFR cores. Next move will depend on how Armour makes out in lining up support.

Research and development briefs

Chemical control of wild oats is possible with a new herbicide now in the experimental stage. Spencer Chemical identifies the compound as 4-chloro-2-butynyl N-(3-chlorophenyl) carbamate, calls it S-847 for short. Growers of cereal grain in the northern U. S. and Canada suffer considerable loss caused by the wild oat weed.

. . . St. Regis Paper Co. hopes to cut down on odorous sulfides and mercaptans in kraft mill discharge to atmosphere. A scheme proposed by University of Washington chemical engineers will be tried in a pilot plant at Tacoma. It involves steam-stripping of objectionable compounds from black liquor, followed by concentration in a distillation column to such an extent that they can be burned.

. . . Mercury cooling of nuclear reactors is slated for study by American Radiator. Compared with other liquid-metal coolants, mercury looks good on several counts, such as low corrosivity, flammability and radioactivity. It may even be possible to use mercury directly as the working turbine fluid.

For more on DEVELOPMENTS.....44

BETWEEN 1958 and 1960 urea capacity will jump an estimated 50%, signaling an end to urea process woes. Here, in a special roundup, you'll find engineering reasons why five processes are now operating well.

Urea Processes Face Bright Future

The flock of urea processes developed in the last 15 years have now reached the stage where they can be called "operational" in the U. S. Last few years has been a difficult period of adjustment while engineers in this country built up a backlog of operational know-how on these processes — developed to get around basic patents held by Du Pont, I.C.I. and I. G. Farben.

Adding to their woes was the fact that all leading processes, except one, were piloted by foreign engineers. Initial U. S. plants had to be engineered from data sheets without experience.

This is why many domestic urea plants have had trouble swinging into full production in the past few years. But now that engineers are learning the intricacies of urea-making, plant on-stream time is climbing.

Building Up Steam

A spokesman for a leading engineering company now calls urea "the hottest product we handle." Industry estimates peg U. S. urea capacity at 900,000 tons/yr. by 1960, almost a 50% jump over early 1958.

Urea is a white crystalline solid (NH_2CONH_2) with melting point around 271 F. Bulk of urea output goes into fertilizers and cattle feeds. All processes are based on the exothermic synthesis and dehydration of ammonium carbamate (NH_4COONH_2):

$$2NH_3 + CO_2 \rightleftarrows NH_4COONH_2 \rightleftarrows NH_2CONH_2 + H_2O$$

Optimizing Yields

Fixing reaction conditions in the urea synthesis reactor is a compromise between several competing factors. Yield of urea increases as temperature and pressure increase. But as temperature increases, corrosion headaches grow proportionately. Too, decomposition of urea into biuret increases as temperature rises.

Selecting operating pressure is a balance between increased yield and increased capital and operating costs for compression and reaction equipment. Most processes stick close to 350 F. and 2,500-3,000 psi. (*Chem. Eng.*, Oct. 1955, pp. 186-190; Mar. 1951, p. 111).

Corrosion Blues

Corrosion and erosion are the main offenders in urea plants. Silver or stainless-steel linings are the most common answer to corrosion in urea reactors. Stainless steel, aluminum, and some of the newer metals such as titanium are used in other parts of high-pressure section. Still, some valves last only months.

Engineers are learning to use a wide range of metals and alloys to check corrosion.

Recycle

Main difference in competing processes is in recycle design. Because urea conversion is usually only 50% per pass, there is always the problem of what to do with unreacted NH_3 and CO_2.

Once-through processes solve this by simply using the NH_3 and CO_2 elsewhere. But since demand for urea is growing faster than demand for byproducts (e.g., ammonium sulfate or nitrate), most new U. S. plants have some scheme for recycling unused raw material. Off-gases can't just be recompressed and recycled because there is danger of solid ammonium carbamate forming in compressors.

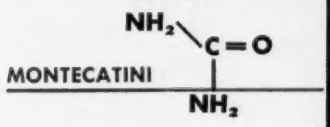
Flowsheets on the following pages show how various process designers get around this problem.

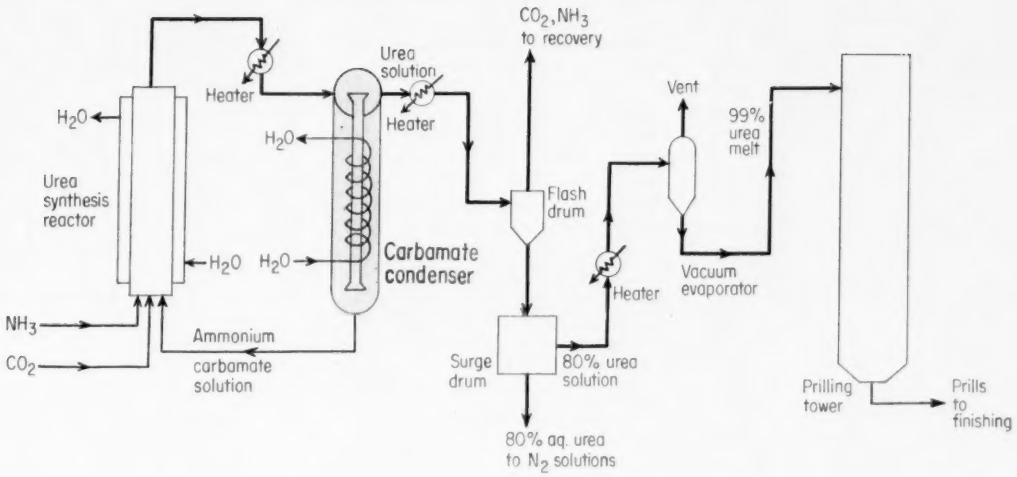
Beware of Biuret

Urea at elevated temperatures tends to decompose into biuret ($NH_2CONH_2CONH_2 \cdot H_2O$). In certain fertilizer applications, especially for leaf sprays, biuret can damage crops. Some specifications call for as low as 0.25% biuret.

In making crystalline urea, there is little problem; it is easy to stay under 0.5% biuret. But in making prills, urea has to be evaporated to 99% solids and this heat promotes biuret formation. The best prilling processes get slightly under 1% biuret; some U. S. plants make prills with as high as 2-3% biuret.

See comparative table, p. 50, What Plants Need to Make Urea.
For details of Inventa urea process, see Process Flowsheet, pp. 78-81.





Montecatini Talks About Spencer Urea Plant

Now on stream at Henderson, partial recycle urea plant claims cost savings via simplified recycle setup and effective corrosion control.

Montecatini's urea process, well-established in plants throughout the world,* has received another vote of confidence. Spencer Chemical Co., which has been operating a 30-ton/day Montecatini once-through plant at Vicksburg, Miss., recently brought on stream a 100-ton/day facility at Henderson, Ky., built around Montecatini's partial recycle process.

Spencer's Engineering Dept. designed the new $3.5-million plant under license from Montecatini of Milan, Italy, and construction was handled by the Spencer-subsidiary, Quaker Valley Construction Co. (Pittsburg, Kan.). Shell Chemical has the other Montecatini plant in the U. S.—a 36,000-ton/yr. unit at Ventura, Calif.

On January 2, 1959, SunOlin and Montecatini announced completion of a license agreement for construction of a new urea plant at North Claymont, Del. Plant will make 73,000 tons/yr. of prills and crystals.

► **No Absorption**—One process feature that attracted Spencer's notice was the patented (U. S. 2,777,877) liquid recycle step—either partial or total—designed to return unreacted NH_3 and CO_2 to synthesis reactor, garnering as close to 100% conversion as desired. Simplified recycle step is claimed to cut cost of extra equipment needed to gain the advantages of a recycle system.

Instead of using selective absorption to separate out unused NH_3 and CO_2 (see flowsheet pp. 78-81), Montecatini employs a combination flash evaporation-condensation step. Here's how it works:

Liquid reaction mass—composed of urea, ammonium carbamate, water, NH_3 and CO_2—at 2,600 psig. is let down to about 400 psig. With the addition of heat, most of the unreacted NH_3 and CO_2 vaporizes, leaving a liquid phase composed mostly of urea and water. Gas phase of NH_3 and CO_2 is drawn off and condensed, forming an aqueous solution of ammonium carbamate. This liquid stream is recycled to the reactor.

► **Total Recycle Option**—By a second expansion step, this time to atmospheric pressure, remainder of unreacted NH_3 and CO_2 in the urea solution is vaporized.

In total recycle version, this gas phase of NH_3-CO_2 is also condensed to ammonium carbamate and recycled to synthesis reactor, giving roughly 100% conversion of feed material to product. When partial recycle is used, as in Spencer's plant, the NH_3-CO_2 gas from the low-pressure separator is piped to other operations in the plant.

Spencer also has rights to total recycle flowsheet although it is only using partial recycle at the present time. Explains Spencer's Assistant Chief Engineer R. W. Hogeboom: "Though

* There are 28 plants in operation, including the three U. S. installations.

it's a real asset to get total conversion, that advantage must be balanced against the cost of achieving it." Extra cost for total recycle comes from installation of a second relatively complex carbamate condenser.

▶ **Added Attractions**—In addition to simplified recycle step, Spencer points to some other dollar-saving features of the partial recycle route.

Corrosion, the infamous bugaboo of urea synthesis, is virtually eliminated by a combination of three factors: Close control over reaction temperature, carefully regulated recycle-stream composition, and the use of stainless-steel-lined equipment. Cutting corrosion means long equipment life, lower maintenance costs and a pure product (less than 5 ppm. Fe).

Too, Spencer points to process' low initial costs. And operating labor expense is slashed to a minimum: Only one operator per shift is needed in the urea synthesis section. (See table on p. 50 for raw material and utility requirements.)

▶ **Reaction Details**—Here is how Montecatini's partial recycle process was engineered to the Spencer plant.

An excess of commercial-grade liquid ammonia is fed to process by a 75-hp. reciprocating pump; CO_2 enters via a 4-stage, 800-hp. reciprocating compressor. Both streams, at 2,600 psig., feed into bottom of reactor along with ammonium carbamate recycle stream.

Urea synthesis reactor stands 55 ft. tall by 3 ft. dia., is a carbon-steel cylinder lined with stainless steel and is fitted with water cooling jacket. Cooling system holds temperature in reactor down to 360 F.

Liquid reactor effluent—urea, ammonium carbamate, water, NH_3 and CO_2—is let down to 400 psig., passes through a shell-and-tube heater, and enters carbamate condenser.

▶ **Unique Condenser**—Carbamate condenser is a 36-ft.-high, 45-in.-dia., two-compartment pressure vessel lined with stainless steel. Upper part of vessel is a gas-liquid separator and lower section is the condenser equipped with a stainless-steel water-cooled coil.

Unreacted gaseous NH_3 and CO_2 in the separator pass through a downcomer pipe and as a result of water cooling, condense and react to form a water solution of ammonium carbamate. This liquid stream exits from bottom of condenser and is pumped back to reactor.

In total recycle process, a second carbamate condenser operating at atmospheric pressure recovers remainder of unreacted NH_3 and CO_2 and recycles it to the reactor.

▶ **Urea Stream Splits**—At Spencer's partial recycle plant, the urea-containing liquid phase from top of carbamate condenser is expanded to atmospheric pressure and flows through a heater to a stainless-steel separator.

Remaining NH_3 and CO_2 pass overhead and are processed elsewhere in the Henderson facility. Liquid remaining in the separator is an 80% aqueous urea solution. It goes to a surge drum where the stream splits, 50% going directly into nitrogen solutions and 50% going into prilled product.

▶ **Beware of Biuret**—To make prills, the 80% urea solution is first concentrated to about 99% in a flash evaporator operating at high vacuum. This is a tricky operation since temperature of urea solution is barely above its crystallization point (about 265 F.) and there is danger of biuret forming through decomposition of the urea.

To minimize biuret formation, holdup time for the concentrated urea solution is a matter of just a few seconds—insuring a final product of less than 0.8% biuret.

▶ **Final Prilling**—After concentration, urea is pumped to the top of a 160-ft. all-aluminum prilling tower and sprays down through a natural countercurrent air draft. Prills are dried to 0.2% moisture, cooled and screened, optionally dusted with kaolin clay, and sent to market.

If desired, drying step can be eliminated, giving prills with under 0.7% moisture (*Chem. Eng.*, Apr. 7, 1958, p. 53).

Urea processes continued on p. 48.

Refiners Revamp Routes, Make Propylene Alkylate

As an effective step toward boosting pool octane numbers, two refiners recently made some significant changes in their alkylation routes and turned in successful efforts with propylene alkylation.

Phillips Petroleum Co., at Sweeny, Tex., has added to its existing HF alkylation setup with increased C_3 concentrator capacity (adding reheat and reboil capacity, new trays) one new acid contactor, and gas-fired reboilers on parallel-operating deisobutanizers.

In a test run, Phillips charged about 5,000 bbl./day of fresh feed (about 23%, by volume, of propylene, 30% normal butane, 35% isobutane) for yields of light and heavy alkylate of about 1,800 bbl./day and 240 bbl./day, respectively. Gas-fired reboilers boosted temperature in deisobutanizers, helped defluorination and lowered consumption of acid.

Unleaded octane number of the alkylate is 92.3, versus 93.5 for alkylation with propylene and butylene feed.

Magnolia Petroleum Co., at Beaumont, Tex., is installing an 8,000-bbl./day propylene alkylation unit using effluent alkylation with five Model 50 Stratco contactors.

A new olefin feed-preparation system recovers 99.9% of the butylenes and 90% of the propylene from 24 Mmscfd. refinery production gas and 14,500 bbl./day of refinery absorption gasoline. This recovery system operates with a 400-psig. fractionation-absorption setup (two towers) and product fractionation to supply a 7,000-bbl./day propylene-rich stream and a 7,000-bbl./day butylene-rich stream.

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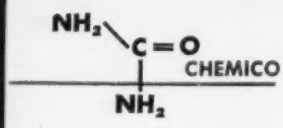

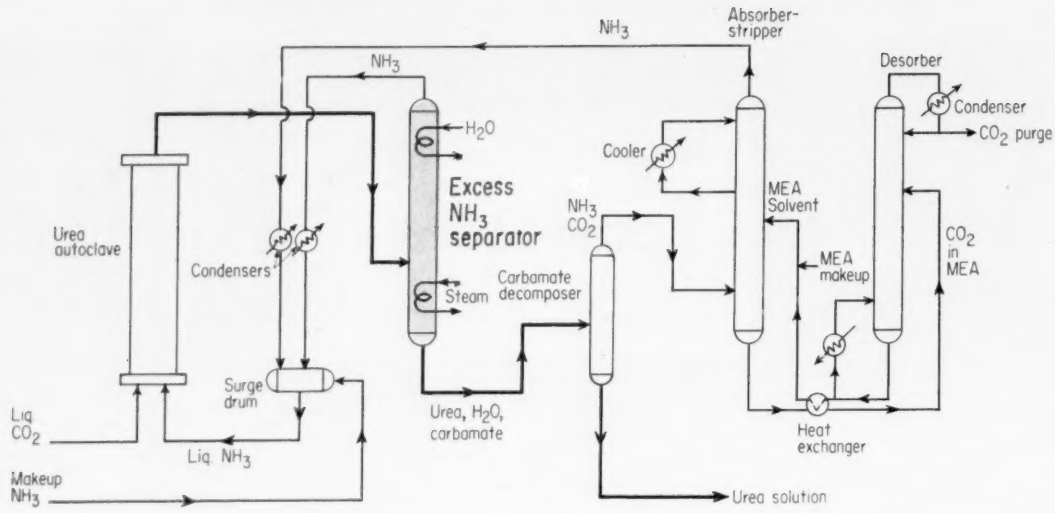

Chemico Adds New Twist to 6:1 Urea Process

A new way to reduce formation of undesirable biuret gets its first trial in American Cyanamid's new plant at Hamilton, Ont.

Chemical Construction Corp., which claims the only American-developed urea process, reveals that it has developed a low-biuret urea crystal process that can be added to its established 6:1 (200% excess NH_3) flowsheet shown above or to its two brand new urea flowsheets —see box below.

Biuret content of crystals made by the new process is guaranteed no more than 0.05%. Called "foliar-grade," these low-biuret crystals meet exacting leaf-spray specifications.

American Cyanamid's new 200-ton/day urea plant at Hamilton, Ont., first to use the new process, is equipped to make 75 tons/day foliar-grade crystals. And Chemico engineers are predicting that actual biuret content will be no higher than 0.03%. Because of pending patents, Chemico isn't saying how it gets this low biuret content other than to point out that it is done by slashing the time that urea solution is in process.

▶ **Bread and Butter**—Chemico's process mainstay has been its original 6:1 process. American Cyanamid's Hamilton plant uses 6:1 with total recycle. Monsanto's 100-ton/day plant at El Dorado, Ark., that came on stream in late '58 uses process with no recycle, making ammonium nitrate with the off-gas.*

Novel feature of Chemico's 6:1 process is the excess ammonia and high autoclave pressure (4,100 psig.) that gets 78% conversion of CO_2 to urea. Most processes get around 50% conversion. This high conversion means there is less off-gas from the carbamate decomposer.

Low-Ratio Processes for Small and Medium Plants

CHEMICO's two new urea flowsheets are based on 2.5:1 mol ratio of NH_3 to CO_2 in reactor feed. Two versions are offered: With and without recycle.

Originally designed for small-tonnage urea plants where the 6:1 process isn't as economical, the process now appears practical for plants of 100 tons/day and more. First installation of the new process will be at the 30-ton/day plant at Lawrence, Kan., for Cooperative Farm Chemicals. Due on stream next summer, plant uses no recycle, utilizing off-gas to make ammonium nitrate.

Selling Points—One advantage of the low-ratio urea process (without recycle) is the relatively small amounts of NH_3-CO_2 off-gas passed to the neutralizer in the nitrate salt plant. Process generates only 0.26 tons NH_3 and 0.13 tons CO_2 per ton of urea, says Chemico.

Patents are pending on the processes so flowsheets and engineering details are unavailable. But process is known to feature "an improved technique for carbamate solution recycle." And process also employs a new synthesis reactor that is more economical than conventional autoclaves for small and medium tonnages. Capital cost ($18,000-20,000/ton of capacity) is less than cost of the 6:1 process.

* Other plants: Sumitomo Chemical, Japan, 200 tons/day; Japan Gas Chemical, 190 tons/day; East Pakistan, 367 tons/day.

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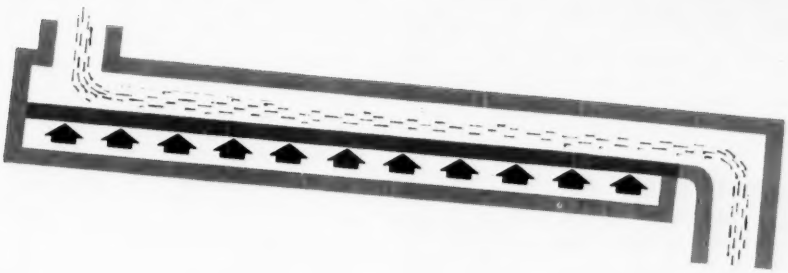

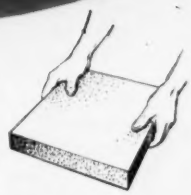

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Q. What distinguishes the KENNEDY AIR-FLOAT from other air-gravity conveyors?

A. *Primarily, the special porous plate. Also the casing is of heavier construction, flanged and channeled for greater rigidity.*

Q. How is this special plate better than other porous media?

A. *The AIR-FLOAT porous plate has literally millions of tiny pores through which the air diffuses uniformly for thorough aeration of the conveyed material. The plate is thicker, stronger, temperature- and wear-resistant, and has a very smooth surface texture.*

Q. How does this improve conveying?

A. *AIR-FLOAT has a much higher capacity than competitive air-gravity conveyors. Blind spots are eliminated and the angle of inclination is less critical.*

Q. What about maintenance?

A. *The KENNEDY AIR-FLOAT is the nearest thing to a completely maintenance-free conveyor that has ever been devised.*

Q. Can turns be made?

A. *Direction changes up to 45° are made with standard pieces. These can be combined for greater angles.*

Q. Are accessories available?

A. *Yes. End and side discharge boxes, splitters, control gates, transitions, bin extractors and required blowers can be provided.*

Q. Have KENNEDY AIR-FLOAT Conveyors been fully tested and proven?

A. *Yes. For more than 12 years AIR-FLOAT Conveyors have been successfully used in KENNEDY-designed cement and lime plants. With this background of experience, KENNEDY is now making AIR-FLOAT available to industry, mass producing it to sell at competitive prices.*

For more information on AIR-FLOAT, ask for Bulletin 58-K.

See pages 419-423 in your Chemical Engineering Catalog for a full listing of Kennedy Products for the Chemical & Process Industries.

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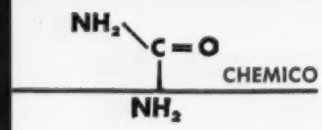

▶ **Extra Ammonia**—Excess NH_3 also means that Chemico needs a piece of equipment not found in other processes: The NH_3 separator. This column, operating at about 250 psig. distills excess NH_3 from autoclave effluent. An ammonia-water reflux keeps the overhead free of CO_2 so there is no problem of carbamate formation in ammonia recycle equipment.

Excess NH_3 also soaks up the heat of reaction in the synthesis autoclave. There is no need for external cooling.

This internal recycle of NH_3 has led to the misnomer "partial recycle" for the Chemico process. Technically, the term "recycle" in any urea process applies only to what is done with the off-gas from the carbamate decomposer.

▶ **Total Recycle**—To make the Chemico flowsheet total recycle, an NH_3-CO_2 separation system is added after the decomposer. Recycle system minimizes trouble, says Chemico, because only pure NH_3 is handled.

To separate NH_3 from CO_2, Chemico takes the opposite approach from the Inventa process. Chemico absorbs CO_2 in monoethanolamine (MEA) and gets a pure NH_3 overhead from absorber. (See Inventa's total recycle system pp. 78-81) Absorbing CO_2 requires smaller absorption system because NH_3:CO_2 ratio in off-gas is roughly 2:1. And Chemico has less off-gas per pound of urea because conversion is high.

On the debit side, initial cost of MEA is fairly high.

▶ **Construction Materials**—Chemico installs two types of autoclaves in its 6:1 plants: Silver or alloy-steel lined. Silver, although more expensive than alloys, lasts indefinitely and gives maximum product purity. Cyanamid's new plant, for example, uses a carbon steel autoclave shell with a silver-coated Monel lining.

Ammonia separator and carbamate decomposer are carbon steel vessels with lead linings. Aluminum finds use in the decomposer separator and in all low pressure lines.

▶ **Prilling**—Chemico now makes prills with less than 1% biuret and 0.5% moisture without extra drying step. Prills do not have to be coated for bulk storage. Secret of the low moisture, low biuret content is to evaporate to 99.6% solids with minimum holdup time.

Chemico's two latest urea plants vary on the placing of the prilling evaporator. At Monsanto's plant it is at the top of the prilling tower while Cyanamid's is at ground level. There are pros and cons for both arrangements: Main reason for putting evaporator at top of prill tower is that concentrated urea does not have far to travel before entering prilling head. This keeps biuret formation to a minimum.

Ground-level evaporator, on the other hand, is less costly to maintain. With evaporator at top of the tower, there must always be an operator on hand—along with the added expense of an elevator for getting him up and down. Individual plant conditions dictate final choice.

Urea processes continued on p. 52.

What Plants Need to Make 1 Ton of Prilled Urea

(Requirements vary with local conditions)

Process	NH_3, tons	CO_2, tons	Power, kwh.	H_2O at 85 F., gal.	150-lb. Steam, lb.	45-lb. Steam, lb.	Approx. Cost 100 ton/day plant, MM$
Montecatini							
Partial recycle	0.88	0.91	165	18,200	4,100		1.1[1]
Total recycle	0.60	0.77	145	27,200	4,800		1.22[1]
Dutch State Mines							
Once-through	1.28	1.75	310	30,000	900	2,300	1.8
Partial recycle	0.82	1.10	230	32,000	1,300	2,700	
Pechiney							
Total recycle	0.58	0.76	190[2]	29,200	1,180	3,750	2.5
Chemico							
6:1 without recycle	0.58	1.06	170[4]	26,000	3,500		2.0
6:1 with recycle	0.59	0.78	215[4]	48,000	4,900		2.5
2.5:1 without recycle	0.60	0.81	190[4]	20,000	3,750		1.8
Inventa[3]							
Once-through	1.14	1.47					
Total recycle	0.57	0.81					

[1] Based on Italian plants, does not include engineering costs. [2] Also needs 1,600 scf. natural gas.
[3] Utility figures are not available. [4] Includes refrigeration.

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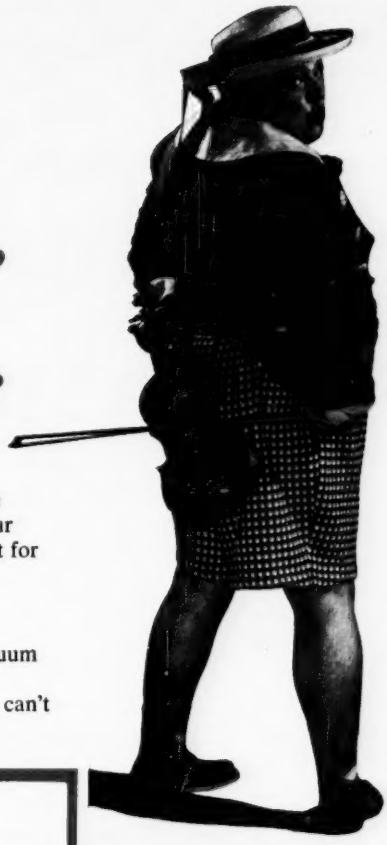

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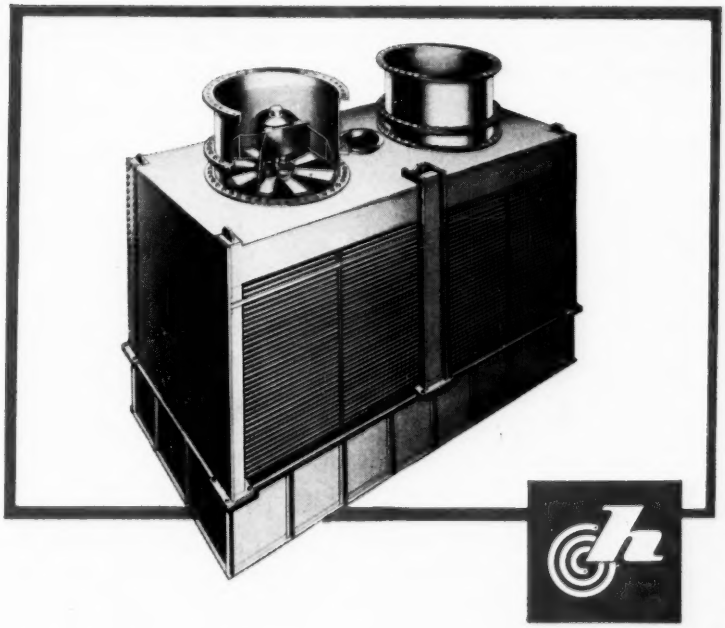

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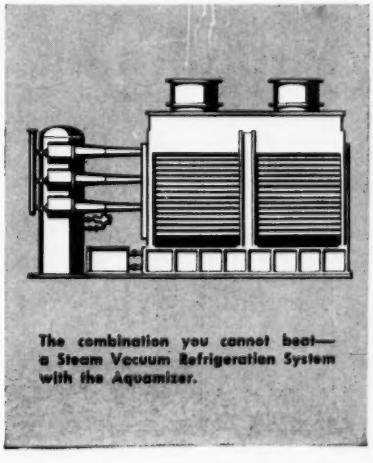

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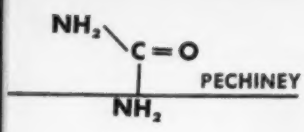

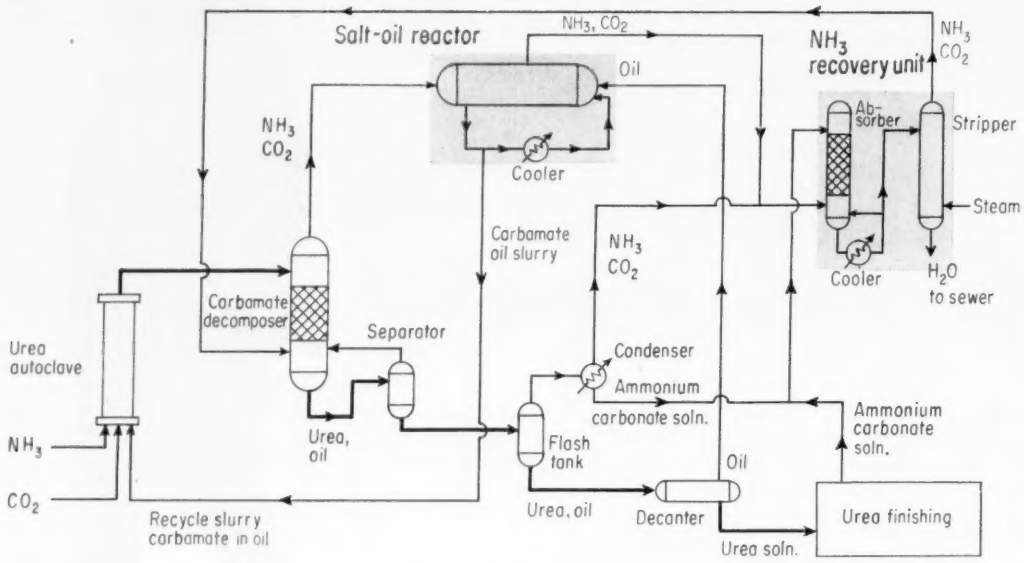

Pechiney Urea Scheme Now Recovers Ammonia

With its novel Pechiney recycle of ammonium carbamate in oil, Foster Wheeler now uses a new recovery system to eliminate ammonia loss.

Two plants in the U. S. make urea via the Pechiney total recycle process, both on stream for about two years (*Chem. Eng.*, Apr. 1955, pp. 320-323). Grace Chemical's plant at Memphis, Tenn., is designed for 150 tons/day and is currently being doubled. Deere & Co.'s plant at Pryor, Okla., is rated at 260 tons/day.

Both of these plants were scaled up from Pechiney's original 3-ton/day pilot plant by Foster Wheeler Corp., New York, N. Y. These first two commercial units had their share of start-up troubles but are now operating at, or above, design capacity.

▶ **Highlights**—Pechiney process was designed specifically for total recycle although a partial recycle flowsheet is available. Novel part of Pechiney process is the recycle system: Unconverted NH_3 and CO_2 are reacted to form a slurry of ammonium carbamate in a light paraffin oil. This salt-oil slurry is recycled to the urea synthesis reactor.

Recycle oil also serves two other purposes: Oil phase acts as a heat sink for the highly exothermic synthesis reaction so that no external cooling is needed. Too, oil in the reactor lessens corrosion; where other processes need stainless steel, lead linings in Pechiney autoclaves have shown no corrosion since startup. Product is lead-free and is sold for all uses including cattle feed.

▶ **Alterations**—Main change in the original Pechiney flowsheet has been the addition of an ammonia recovery system. Grace's plant was losing 10 tons/day NH_3, mainly from NH_3 dissolved in the urea solution from the bottom of the carbamate decomposer.

No provision was made for recovering NH_3 in the original plant because no one was sure it would be needed: Complex equilibrium at the base of the decomposer made it uncertain how much dissolved NH_3 there would be in the urea-oil mixture at that point.

Recovery system solvent is a stream of ammonium carbonate from the flash-tank condenser and from urea evaporation step. In the packed absorption tower, the ammonium carbonate absorbs all NH_3 and CO_2 gas from salt-oil reactor and low-pressure flash tank. A second column steam-strips all the NH_3 and CO_2, sending water to the sewer.

This system reduces NH_3 losses to those that can be chalked up to pump leakage and solids handling.

▶ **React and Strip**—Pechiney's autoclave operates at 360 F. and 3,000 psig.

Effluent from synthesis reactor depressures through letdown valve to 60 psig. and heat decomposes carbamate. Stripped NH_3 and CO_2 flows to the salt-oil reactor.

Oil-urea phase from carbamate decomposer flashes under vacuum to cool it for decantation. In decanter, urea separates from recycle oil; underflow is an aqueous urea solution that

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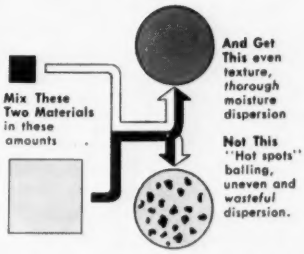
Want Proof?

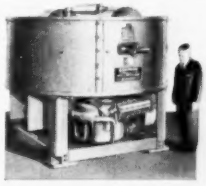
A list of Mix-Muller users will be sent upon request—together with the *Handbook on Mulling* or, write for details on a confidential *mulling* survey of your product . . . conducted under strictest laboratory conditions.



Here's how *controlled mulling* works:

Diagram shows comparative results of blending a minute amount of one material with large amount of another material in (A) MIX-MULLER and (B) conventional mixer. Savings in raw material, reprocessing time and quality of finished product are the outstanding *rewards* of mulling your product.

Simpson Mix-Mullers are available in batch capacities of from ½ to 60 cubic ft. They can be equipped for heating, cooling or chemical interaction during mixing and can be furnished in stainless, alloys or other special materials or linings.



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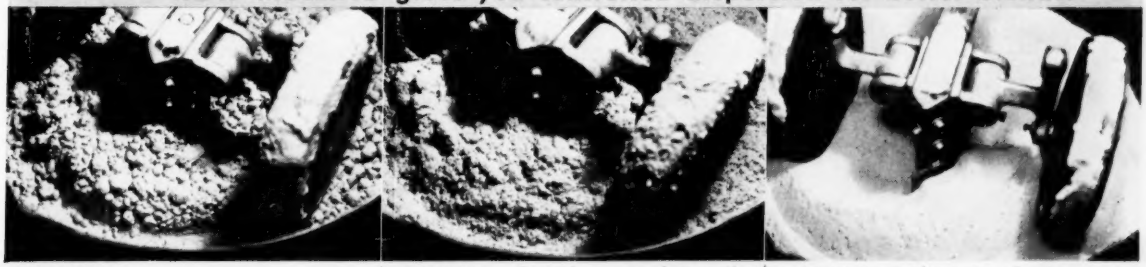

GOING: Mix is wetted, dispersion of coating media begins as lumps form.

GOING: Smearing, *spatulate* action breaks up lumps as mulling action disperses moisture.

GONE: Agglomerates almost gone as blending nears completion. Mix is homogeneous, thorough.

is processed into prills or crystals.

▶ **Recycle**—The salt-oil reactors, heart of the recycle system, are horizontal vessels, partially filled with oil at 150-200 F. A series of impeller disks coats interior with oil.

Ammonia and CO_2 react exothermically in the oil to form small particles of ammonium carbamate. Heat of reaction is removed by circulating slurry through cooler and back into reactor. Particle size—a function of design—is critical: If there are any surfaces not coated with oil, large lumps of carbamate will form. Particles must be small to remain slurried during pumping. And large lumps cause excessive valve erosion.

▶ **New Design**—Original salt-oil reactors were scaled up from Pechiney's 3-ton/day pilot plant. But commercial units proved complex and troublesome mechanically; mechanical seals and oil level control were particular trouble-spots for the operators.

Improved salt-oil reactor was finally worked out through piloting at Pechiney's plant and tests at the Deere and Grace plants. Foster Wheeler will not go into the details of the new reactor except to say that it employs standard American equipment without special mechanical design.

▶ **Killing the Bugs**—Most of the start-up difficulties stemmed from erosion and corrosion. Example: Let-down valve from autoclave eroded rapidly and would not close tightly. This was solved by putting in two valves—one for flow control and one for shut-off.

Valves on the salt-oil pumps that boost recycle stream to 3,000 psig. were giving out in a matter of hours. Main difficulty was in the carbamate-oil slurry: Entrained gases were causing valve slamming and large particles were eroding valve seats. This was licked by improved salt-oil reactors that give uniform slurry; valve life has been extended to one month or more.

Dutch Urea Process Stresses Prill Quality

New Trinidad plant will use Dutch State Mines process to produce, without drying, strong prills that contain only 0.3% moisture.

Newcomer on the Western Hemisphere urea scene is the Dutch State Mines (Staatsmijnen) process—a once-through process with a partial recycle variation. Process will be used in a 70-ton/day unit being built on the island of Trinidad for Federation Chemicals, Ltd., in which W. R. Grace has a financial interest. C. F. Braun, Alhambra, Calif., handled the engineering.

The DSM process is already being used in a 150-ton/day Staatsmijnen plant in Holland. And a big 300-ton/day partial recycle plant for African Explosives & Chemical Industries has just come on stream in South Africa. Another 140-ton/day unit is being built for Societe Carbochemique in Belgium.

Grace, a user of the Pechiney total recycle process in its Memphis, Tenn., plant, picked the DSM once-through flowsheet for marketing reasons. On Trinidad there is a market for ammonium sulfate as well as urea; process makes ammonium sulfate by neutralizing sulfuric acid with the NH_3 off-gas.

▶ **Makes Strong Prills**—Not many engineering details are available on the DSM process. One of its main selling points, though, is the quality of the prills.

A "new prilling technique" in use since 1955 gives a mechanically strong prill with only 1% biuret and 0.3% moisture without extra drying steps. Drying, says DSM, weakens the prill. Prills can also be stored in bulk without coating; many processors coat prills to prevent caking during storage.

Only thing known about the new prilling technique is that it uses a special evaporator mounted on top of the prill tower.

Quality of the DSM prills has even won grudging compliments from competitors in the industry. They say that DSM was among the first to make a satisfactory prill with less than 1% biuret.

▶ **Checks Corrosion**—Another DSM process feature is its patented method for checking corrosion in the synthesis reactor (*Chem. Eng.*, Aug. 11, 1958, p. 73). Staatsmijnen uses ordinary stainless-steel reactor linings—such as type 18-8—and injects "small amounts" of oxygen into the reactor to inactivate the stainless and "completely eliminate" corrosion. Other processors using stainless-lined reactors are believed to use an air-injection system to thwart corrosion.

DSM also says that its stainless let-down valves last four years—a creditable service life. Stainless is used throughout the low-pressure section which "prevents any corrosion."

For small-tonnage plants, DSM uses a pipe-type synthesis reactor; the circulating cooling water which controls reaction temperature also generates steam that can be utilized later in decomposing carbamate. For large plants, however, DSM reverts to the more conventional autoclave design used in most U. S. urea plants.

▶ **Feed Variables**—Molar feed ratio of NH_3 and CO_2 can be varied from 2:1 (stoichiometric) to 5:1 to get most economical operation at varying plant conditions. Partial recycle system is added if it is desired

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to cut down the amount of off-gas per ton of urea.

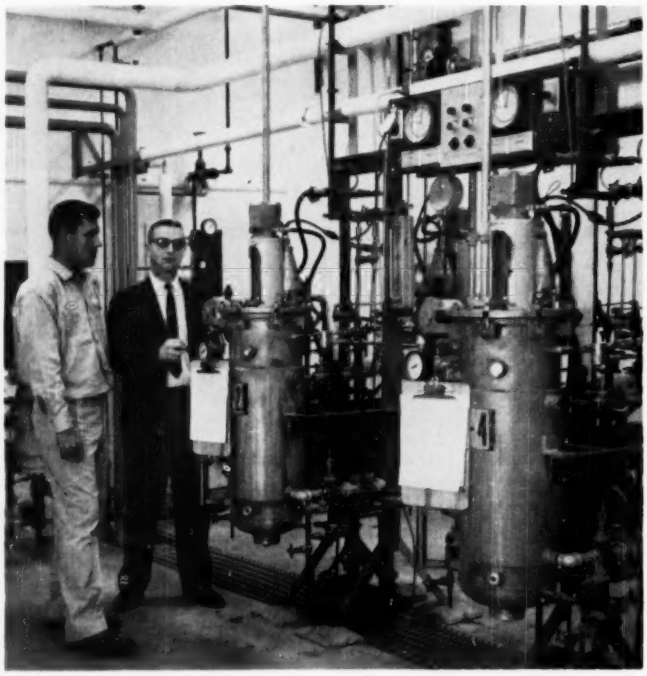
Purity of CO_2 in the feed stream is not critical; process will tolerate up to 3% inerts. (Sulfur must be reduced to a few parts per million, however.) Other processes require up to 99% CO_2 purity.

▶ **Flowsheet**—Reaction conditions in the DSM process are fairly standard: About 350 F. and 3,000 psig.

Reaction mass from the synthesis reactor depressures to about 300 psig. in the first carbamate decomposer. Bottoms of urea, water and some carbamate expand to 1 atm. and remaining carbamate decomposes to NH_3 and CO_2. Purified urea melt from bottom of low-pressure decomposer is pumped to the evaporation and prilling steps.

Medium-pressure (300 psig.) off-gas combines with the low-pressure off-gas and passes to the neutralizer in the byproduct salt plant.

Partial recycle variation involves tapping a portion of the high-pressure (3,000 psig.) reactor effluent and passing to recycle system which returns unreacted carbamate to reactors. Urea taken out with the recycle side-stream is put back in the 300-psig. section of the synthesis system.



Plant Makes Like a Mediterranean Flour Moth

Pilot studies at Bioferm Corp. have resulted in the first commercial plant, at Wasco, Calif., to produce a biological pest-control agent, Thuricide. The active agents are live spores of *Bacillus thuringiensis*, a bacterium first isolated from diseased larvae of the Mediterranean flour moth. Miniature fermenters, above, keyed design of successful submerged culture process and smooth startup of full-scale production.

NEWS BRIEFS

Temporary bulk storage: Southwest Research Institute has completed a year of design studies for construction of temporary, large-scale bulk storage of petroleum fuel in tanks of 1,000, 10,000 and 50,000-bbl. capacities. Designs involve use of large, synthetic-rubber-coated fabric sheets as impervious liners spread over earthen walls. A flexible cover of the material floats on the surface to reduce evaporation and prevent contamination. SRI estimates that field construction time for a 50,000-bbl. tank would be about 500 man-hours—about one-tenth that for erection of a conventional steel tank.

Formaldehyde: Institute of Chemical Physics of the USSR Academy of Sciences reports that it has made formaldehyde by direct air-oxidation of natural gas. Process is said to halve costs, and will be used in a plant now under construction at Tataria.

Uranium: Fremont Minerals, Inc., has started processing uranium ore at its 500-ton/day Riverton, Wyo., mill. It's the first uranium mill to combine acid and alkaline routes (*Chem. Eng.*, Feb. 24, 1958, p. 60).

Atomic Energy Commission expects to close its 600-ton/day uranium-recovery mill at Monticello, Utah. Mill, operated by National Lead Co., will close about mid-1959 and will probably be placed on stand-by basis as a national defense facility.

Oil and gas: Russia is projecting capital investment in the oil and gas industry, from 1959 to 1965, at the equivalent of $42.5 to $43.25 billion.

Nose cone: Coors Porcelain Co., Golden, Colo., has started development of a ceramic nose cone for the Bomarc guided missile. Previously, Coors developed nose-cone models from alumina ceramics for the Nike Zeus.

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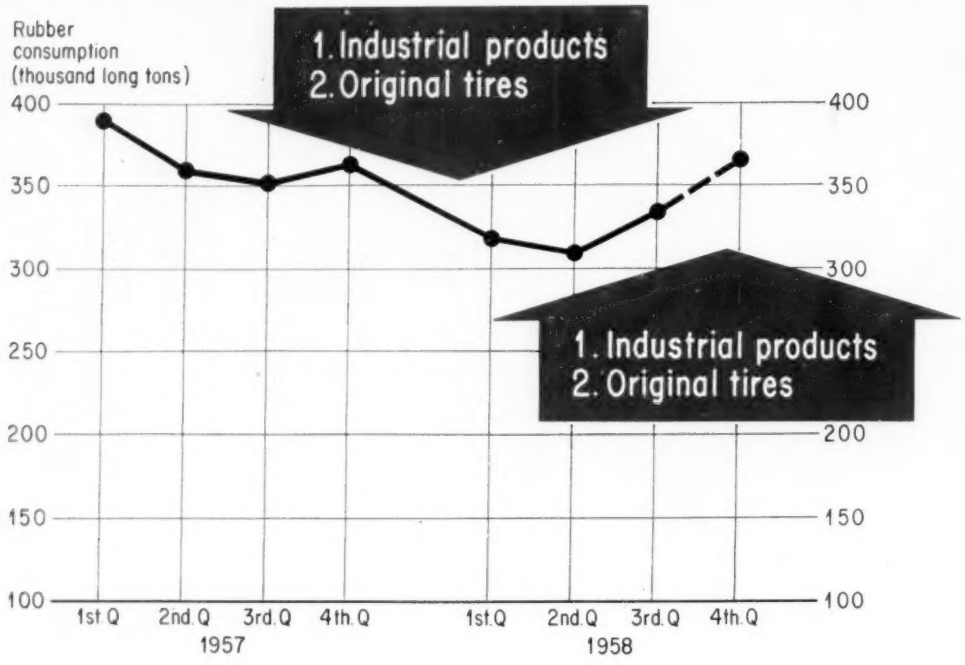
Recession and Recovery for Rubber . . .
. . . pivoting on same markets:



Industry, Autos Give Rubber a Fast Bounce

Weakening demand from industry and auto makers tumbled rubber producers into a slump. Pickup in the same markets is pulling them up just as fast.

Karl O. Nygaard, The B. F. Goodrich Co., Akron, O.*

For the rubber industry, 1958 was a year of rapid change from recession to recovery, a year marked by a zig-zag of sharp declines in sales and production, followed by rapid improvement. It was a year with tremendous variations in market conditions, product line by product line.

A relatively sudden weakening in two vital rubber markets —industrial products and new-car tires—plummeted the industry into the recession. An equally quick turnaround of these same markets has prodded the rubber industry into a solid recovery climb. All signs point to a very good year in 1959.

The long-term rubber picture features a spirited buildup of synthetic rubber capacity in the other free nations of the world. By 1962 these nations—with a total synthetic capacity of more than 600,000 long tons/yr.—will be well equipped to compete for world rubber markets.

▶ **Down and Up**—Recession for the rubber industry began in August 1957. In the next eight months, monthly rubber production rates (Federal Reserve Board Index) were slashed 21%. Of all other major manufacturing industries, only three—automotive, electrical machinery and primary metals—fared worse.

Industry new-rubber consumption in 1958 ran about 1,330,000 long tons, 9% below 1957 and way under the estimate for 1958.

* Mr. Nygaard is director of business research for B. F. Goodrich. This story is based on a talk he gave at the annual meeting of the Rubber Manufacturers Assn. in New York last November.

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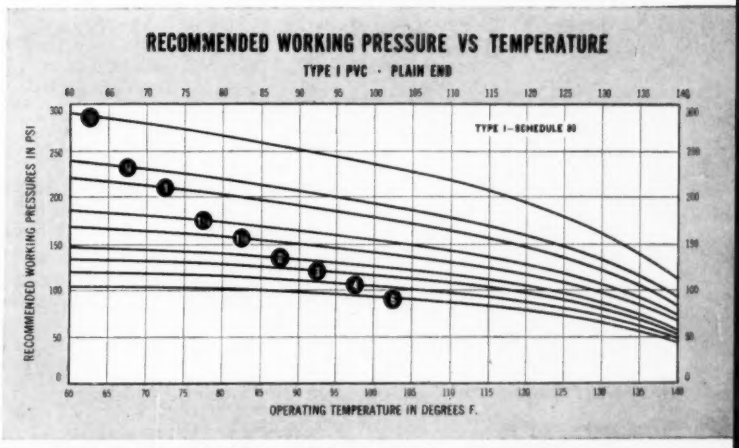

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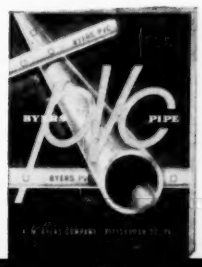

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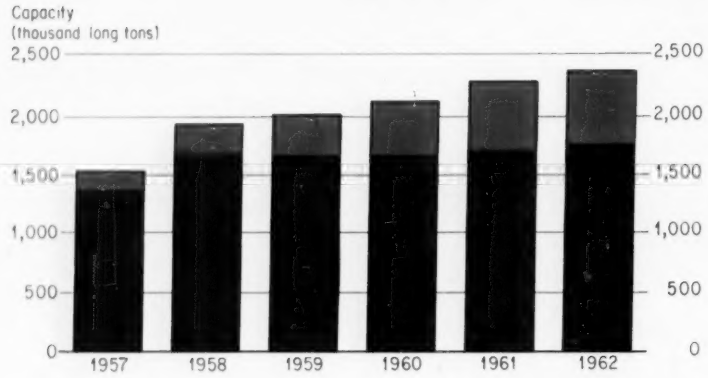
Synthetic Rubber Capacity:

Overseas buildup will force U. S. slowdown



Then, in April last year, the shift from business contraction to business expansion got underway. First, the downslide in new orders for major industrial rubber products was halted, then reversed. The second recovery point coincides with the beginning of full scale production of 1959 automobiles, buses and trucks.

The remarkable fact is that recovery in the rubber industry since April has been just as rapid as was the decline prior to April (see chart, p. 58). New rubber consumption had reached the bottom in the second quarter last year—only 313,000 long tons—the lowest quarter since 1954.

Now note the increase in consumption for the third quarter, usually the low quarter of the year. Consumption in the fourth quarter is estimated at 364,000 long tons, a full 16% better than in the second quarter and equal to the final three months of 1957.

All signs indicate that recovery in the rubber industry will carry over this year. A sizeable gain in consumer spending for new cars and other durable goods, an early upturn in business plant and equipment expenditures, and some rebuilding of business inventories depleted during the past year will mean a real expansion in markets for rubber products.

Industry is expected to consume about 1,500,000 long tons of new rubber in 1959, up 13% from last year.

▶ **Not Much Warning**—Actually, there were no clear signs of recession in rubber consumption before December 1957. Consumption was, in fact, running ahead of the year before.

Shipments of replacement tires for passenger cars were unusually strong through October 1957. Then in November the replacement truck-tire market contracted sharply and passenger-car-tire replacements slipped a little.

Demand for original-equipment tires was fairly strong to the end of 1957. New-car production was running at an annual rate of 6 million units from August right through February 1958—five months after the general business recession was underway. Truck production held up even longer.

In many ways it was easy to misjudge the recession because it often refused to behave like one.*

Thus, although automotive-industry cutbacks eventually hurt the rubber industry grievously — passenger-car-tire demand was shaved by 9.5 million units in 1958, while bus-truck tire shipments fell off 19%—the general business recession did not get its start in the automotive industry.

* Available statistical information on rubber industry activity gave little warning that a serious recession was in the offing. Apparently, production in some industry areas went ahead almost as if sales expectations were not already rolling down hill. The sun was shining out the front window, but it was raining in the backyard.

▶ **Guilty Party**—The real recession spark came from a decline in business capital outlays and a switch from general business inventory accumulation to substantial inventory liquidation.

Plant and equipment expenditures—breezing along at an annual rate of almost $38 billion in the third quarter of 1957—were reduced by more than $5 billion, or 14%, within six months.

And by the first quarter of 1958, business inventories were being liquidated at an annual rate of $9.5 billion—compared to a $2-billion accumulation rate in 1957's third quarter.

▶ **Rubber Everywhere** — Industrial rubber products were hit hard by this spending slowup—as they had been in previous business downturns. For industrial rubber products are used widely through American industry. There is hardly a manufacturing establishment that does not require some hose, belting, or other industrial rubber items in its operations. And, of course, rubber products are an essential component of many manufactured products.

Nevertheless, some other major markets did manage to hold their own throughout 1958 and kept the recession from being worse than it was for the rubber industry.

▶ **Replacement Market Strong**—The replacement-tire market showed unusual strength in 1958. Industry shipments of replacement car tires totaled an estimated 59.5 million units, a healthy 5% gain over 1957. Demand for replacement truck-bus tires was quite weak in the first half on 1958, but since then has shown real improvement, reaching an estimated level in 1958 of 8.8 million units, 3.3% better than 1957. Replacement farm-equipment tires were up 13.8% last year.

These gains were almost enough to offset completely the decline in original-equipment business. All pneumatic tires were down about 7%.

Demand for consumer-type rubber products held up reasonably well last year. Shipments of footwear made by the rubber industry showed a small gain over 1957. And sales of rubber

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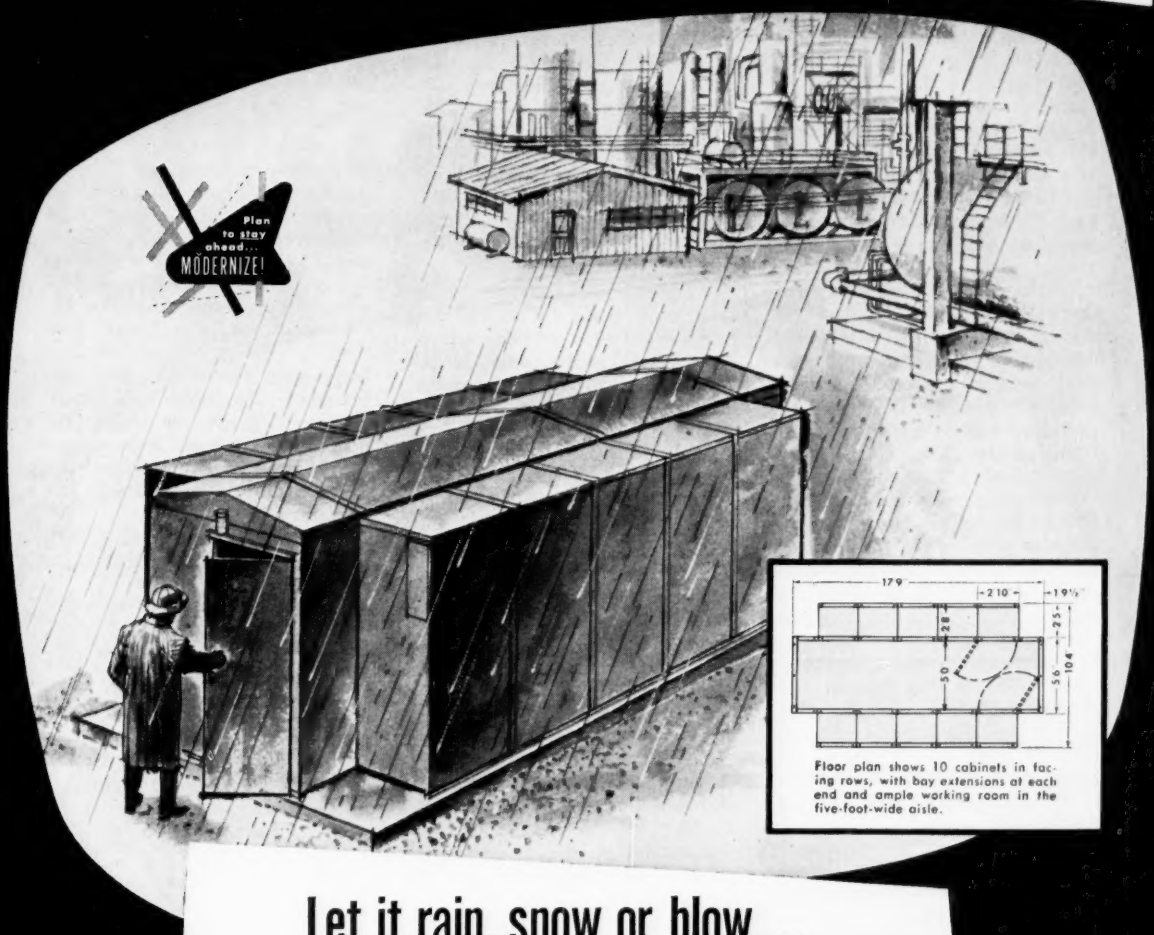

Floor plan shows 10 cabinets in facing rows, with bay extensions at each end and ample working room in the five-foot-wide aisle.

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For details, contact the A-C office near you, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

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drug sundries came close to matching those of 1957.

New-rubber consumption in the world totaled an estimated 3,130,000 long tons in 1958, nearly equal to the amount consumed in 1957. Rising demand in the free world outside the U. S., and a sharp stepup in natural rubber imports by the Soviet bloc countries—350,000 long tons, 20% more than in 1957—offset the decline in U. S. new-rubber requirements.

▶ **Synthetic Still Gains** — Synthetic rubber will account for virtually all the increase in world new-rubber supplies over the next several years. Synthetic capacity outside the U. S. is growing especially rapidly, accounting for the bulk of the world increase.

Last year an estimated 225,000 long tons of synthetic rubber was produced in free nations outside the U. S. By 1962 production capacity in these nations will have almost tripled (see chart, p. 60).

These same nations consumed about 375,000 long tons of synthetic rubber last year. This represents about 25% of their total rubber requirements, up from 20% in 1956.

We have made no allowance, in these trends, for the synthetic natural rubbers, the man-made rubbers which duplicate the properties of the tree-grown variety in every way. Pilot-plant production of these rubbers has been achieved, and test results of products made from them look favorable.

From a cost standpoint, natural rubber produced on a efficient estate holds a substantial edge on these synthetic natural rubbers. But so long as the price of natural rubber is not competitive with synthetic rubber, these synthetic natural rubbers have a place in the total new-rubber supply-demand situation.

Perchlorates, Rare Earths, Thorium, Lithium

At a recent meeting with McGraw-Hill editors, Peter Colefax, president of American Potash & Chemical Corp., had some interesting things to say about some of his company's new and more intriguing chemical products.

Ammonium Perchlorate—Perhaps the most interesting electrochemical today is ammonium perchlorate, the oxidizer generally used in solid propellants. "The growth curve for ammonium perchlorate appears strong. We would guess that consumption in 1959 will be 40% above 1958; in 1960, 90% above; and in 1961, around 140% above."

Ampot operates the only large-scale plant for ammonium perchlorate — at Henderson, Nev.—although two small plants are being built by other chemical companies.

Rare Earths and Thorium—Domestic use of rare earth oxides has grown about 12%/yr.—exclusive of government stockpiling—for the past four years, and should continue to grow. "We are optimistic regarding their future, partly because we can now offer the individual purified rare earths at lower price levels and in quantity as a result of new ion exchange production processes that have replaced previous fractional crystallization." (Ampot is very strong in this field, having acquired Lindsay Chemical in May last year. Lindsay leads in production of rare earth elements and thorium and ytterium compounds.)

A number of individual rare earth oxides are of interest as control-rod poisons in atomic energy work. Now that pure compounds are available, rare earths should get bigger play in glass manufacture and, as catalysts, in polymerization reactions leading to, say, plastics.

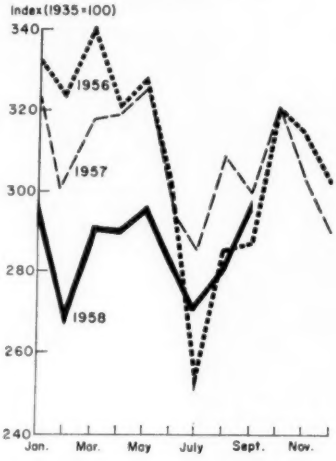
Thorium's major industrial outlet was, until recently, in the manufacture of gas mantles. But there's been a big rise the last two years in the use of alloys of thorium with magnesium. Another major thorium potential: use in nuclear "breeder" reactors.

Lithium Chemicals—Expect lithium markets to grow 5-8%/yr. Lithium carbonate represents more than 35% of these markets, most of it going to ceramic glazes and porcelain enamels. Most lithium carbonate used today comes from American Potash's plant at Trona, Calif.

Ampot's San Antonio, Tex., plant supplies lithium hydroxide to the AEC, then buys it back—depleted in isotope-6—from the AEC and resells it to industry. More than 30% of all lithium hydroxide goes to the grease market, a market which should increase about 5%/yr.

Lithium chemicals are in ample supply. Some have said they are in oversupply. "However, we believe that a reliable source of supply offers considerable encouragement for the development of significant new uses." Under consideration: large-scale use of lithium compounds in aluminum production. And certain lithium derivatives are under study as high-energy components of solid propellants (e.g., lithium perchlorate as the oxidizer).

Chemical Consumption



Consumption by Industries

	Aug. (Final)	Sept. (Est)
Coal products	7.5	7.7
Explosives	10.5	11.0
Fertilizer	48.8	56.2
Glass	29.2	27.8
Iron & steel	13.4	14.0
Leather	4.1	4.2
Paint & varnish	35.7	35.6
Petroleum refining	31.5	30.1
Plastics	23.5	29.6
Pulp & paper	37.7	36.7
Rayon	23.7	25.2
Rubber	5.2	6.8
Textiles	9.2	9.2
Total	**280**	**294**

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to heat and fluids

VITON synthetic rubber combines high resistance to oils, fuels, solvents and corrosive chemicals with outstanding resistance to high temperatures—from 400° F. to 450° F. in continuous service and up to 600° F. in intermittent service.

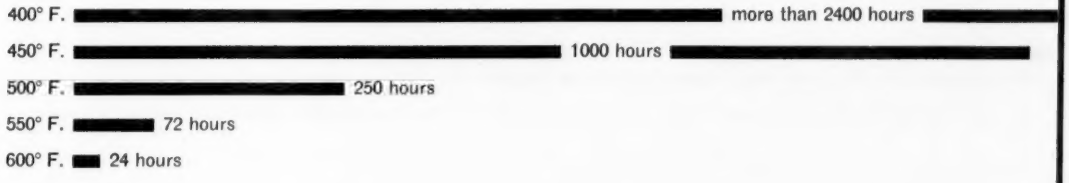
VITON has excellent mechanical properties . . . such as low compression set, high modulus and good tensile strength . . . plus resistance to ozone, oxygen and weathering.

VITON meets the need for a new rubber that will serve where ordinary synthetic rubbers fail. It offers the chemical processing industry such products as gaskets, O-rings, seals, coated fabrics, hose, tubing and a great variety of parts that will perform over an unusually wide range of operating conditions.

Ask your rubber goods supplier about VITON. For more information on its properties and uses write to: E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. CE-1, Wilmington 98, Delaware.

VITON RESISTS HEAT

Periods of time for which VITON vulcanizates have remained usefully elastic when oven aged in air at the temperatures shown.



VITON RESISTS CHEMICALS

Data obtained by immersing VITON vulcanizates for 7 days and measuring effect on properties shown. Original properties of test compound; tensile strength, 2400 psi; elongation at break, 200%; hardness, shore A, 71; modulus @ 100%, 700 psi.

	Temperature	Tensile strength retained %	Volume increase %	Hardness change, points
Carbon disulfide	75° F.	98	1.2	−11
Carbon tetrachloride	75° F.	85	1.3	+ 2
JP-5 petroleum aircraft fuel	75° F.	100	0.4	+ 1
Sulfuric acid, fuming	75° F.	58	4.8	− 4
Dichlorobenzene	158° F.	81	10.5	−11
Sodium hydroxide, 50%	158° F.	89	5.1	− 8
Phosphoric acid, 60%	212° F.	93	0.5	0
Water	212° F.	98	2.7	+ 3
Sulfuric acid, 60%	250° F.	102	5.2	− 3
Petroleum oil, crude	300° F.	91	1.4	− 9
Oronite 8200 silicate ester	300° F.	93	1.8	0
Water	400° F.	45	4.0	+16

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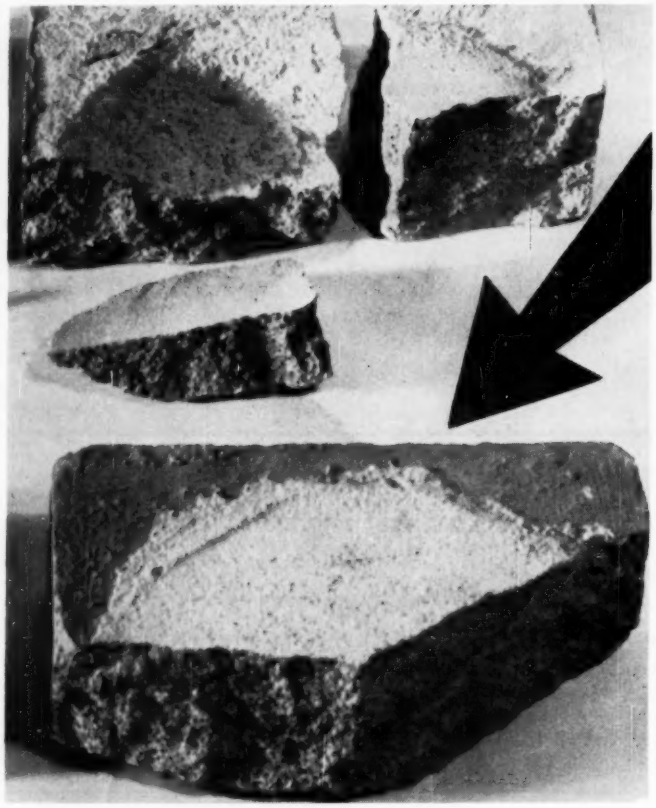
CHEMICAL PRODUCTS EDITED BY FRANCES ARNE



New Adhesive Keeps Concrete Patched After Blow

New epoxy-nylon type resin formulation called Uniweld can form a permanent joint and water and vapor barrier between wet concrete and cured concrete. The whole contact area welds without any mechanical interlocking. Tension, compression, shear and impact tests show that the bond is many times stronger and tougher than even fully hardened concrete.

Currently marketed concrete joining materials with rubber-latex, polyvinyl acetate, butadiene-styrene or other bases do not resist all forms of moisture and depend for strength primarily on a mechanical interlocking of the joined faces. Photograph shows how concrete patched with old adhesive cracked at the seam when hit with a hammer; new adhesive keeps patched block intact.

Epoxies are the only known materials which will form a tenacious bond with cured concrete. Because Uniweld is thermosetting rather than thermoplastic, the curing process is irreversible and permanent. It does not depend on the evaporation of moisture or solvents and is totally unaffected by water, alkalis, mild acids. — Permagile Corp. of America, New York, N. Y. 64A

Diethers

Improve viscosity-temperature characteristics of fluids, lubes.

Commercial availability of a new series of Ucon fluids and lubricants has been announced. Designated as the DLB series, the new materials differ from the company's LB series of polyalkylene glycols in that they are diethers and have no terminal hydroxyl group. The different structures impart better viscosity-temperature qualities, complete solubility in hydrocarbons. Chemical reactivity is reduced since they have no functionally active groups.

Priced at 40¢/lb. in tank car lots, the new series of polyalkylene glycol diethers is available in three different viscosity grades: 62E, 140E and 200-E. The numbers in the grade designations indicate approximate viscosities in Saybolt Universal Seconds at 100 F.

The materials are expected to find use in the formulation of greases, hydraulic oils, power transmission fluids, and gear oils. Preliminary data indicate suitability of the series as radiation-resistant fluids and lubricants at moderate levels of radiation, temperatures below 500 F.—**Union Carbide Chemicals Co., New York.** 64B

Insecticide

Silica gel insecticide "dries" insects to death.

Experimental quantities of Dri-Die, a new type of insecticide, have been released for evaluation by members of the National Pest Control Assn. and state and federal agricultural departments.

The material is a treated silica aerogel, a very fine (micron-sized) white powder derived from sodium silicate and sulfuric acid. It acts by attacking the essential waxy coat-

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Nickel Carbonate	Nickel Formate	Nickel Nitrate
Nickel Sulfate	Sodium Methoxide	Zinc Nitrate

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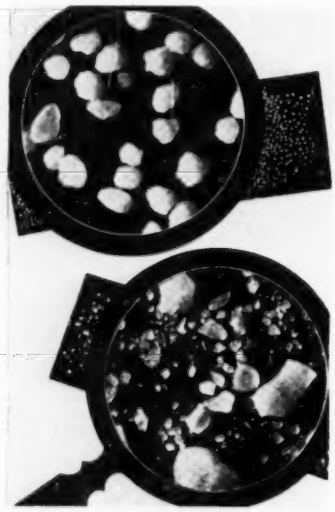
ing which protects the body moisture of insects.

It has been shown to be very effective in extensive tests on roaches and wood termites and has shown promise in limited tests on houseflies, mosquitoes, ants, fleas, ticks and other insects.

A prospective advantage of the product, in addition to its lethal qualities, is that its action is fundamentally physical. Entomologists believe accordingly that insects may not develop the tolerances experienced with organic insecticides. **—Davison Chemical Co., Baltimore, Md. 64C**



Na m-Silicate

New round profile, top, allows closer sizing than old sharp shapes.

New sodium metasilicate pentahydrate called Crystamet owes its unusually uniform particle size and rounded profile to a new crystallizing process. In addition to improving the product, process operates more efficiently than conventional processes because it is continuous and uses anhydrous sodium metasilicate as a raw material.

Previously, all commercial sodium metasilicate pentahydrate was crystallized in molds or as a thick layer on a moving belt. It was then ground and screened to give a product with a necessarily wide particle size distribution since too coarse material had to be recycled to the grinder and material that was too fine had to be remelted and crystallized again. With such a process, a product with a narrow particle size distribution could not be economically produced.

The new Crystamet 2040 has a minimum of 90% by weight passing through a 20 mesh screen and retained on a 40 mesh screen. Crystamet 1020, the coarser grade, runs at least 80% between 10 and 20 mesh.

The rounded, uniform particles tend to roll easily and have a lower angle of repose. Contact between particles is reduced to minimum by their shape and the tendency toward "nesting" of the particles is reduced due to their size uniformity. As a result, the tendency toward caking in the presence of small amounts of moisture is greatly reduced.

The uniform particle size also entails a freedom from unpleasant alkali dust and eliminates any tendency toward segregation on shipment when blended with materials of similar particle size. **— Cowles Chemical Co., Cleveland, Ohio. 66A**

Polyethylene

For coilable pipe with best initial burst strength to date.

Greater initial burst strength than was heretofore available in coilable pipe is said to be provided by a new polyethylene resin. The new material combines its high initial strength with proportionally longer service life as well as usual high-performance characteristics required in pipe applications.

Tests conducted during development of the new resin indicated that pipe's instantaneous burst strength is proportional to the density of the resin. Both the density and the material's melt index determine the resistance to environmental stress cracking and the stress level maintained in long-term pressure testing. With a density of 0.930 and melt index of 1.2, the new resin aims at combining as high a density and as low a melt index as will permit easy extrusion. The pipe compound based on this resin is designated DHD-4022.

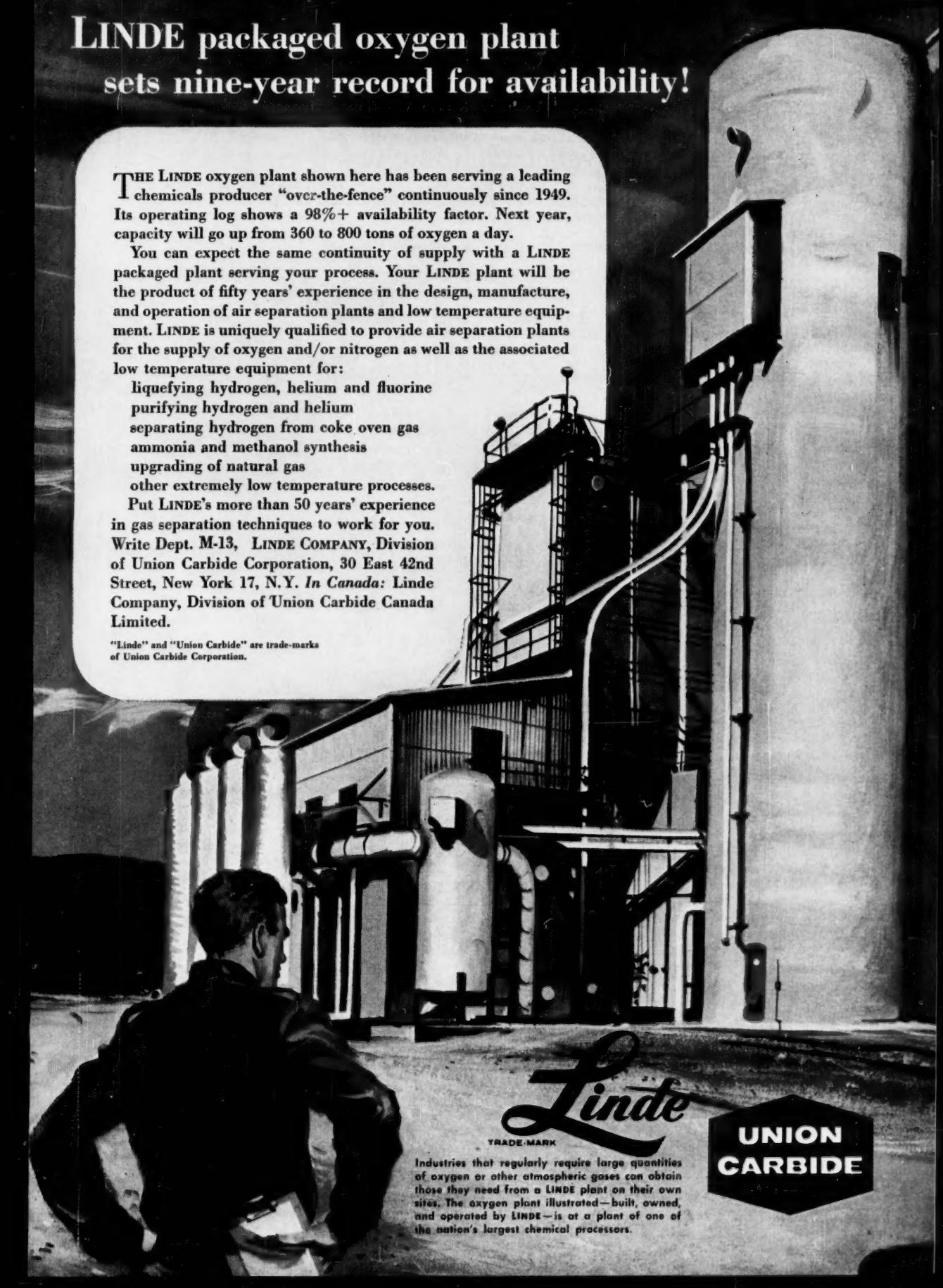
Thus major strength advantages of this material over conventional first-grade pipe compounds include: An increase in instantaneous burst strength, higher long-term resistance to stress at room temperature, and significant improvement in resistance to environmental stress cracking.

Because of its higher strength, DHD-4022 can be extruded into thinner walled pipe than ordinarilly formed from current high-grade materials, thus reducing the cost of finished pipe. The new material can be extruded on any standard extruder, employing material temperatures ranging

Newsworthy Chemicals

For more details, use Reader Service Card

LINDE packaged oxygen plant sets nine-year record for availability!



THE LINDE oxygen plant shown here has been serving a leading chemicals producer "over-the-fence" continuously since 1949. Its operating log shows a 98%+ availability factor. Next year, capacity will go up from 360 to 800 tons of oxygen a day.

You can expect the same continuity of supply with a LINDE packaged plant serving your process. Your LINDE plant will be the product of fifty years' experience in the design, manufacture, and operation of air separation plants and low temperature equipment. LINDE is uniquely qualified to provide air separation plants for the supply of oxygen and/or nitrogen as well as the associated low temperature equipment for:

liquefying hydrogen, helium and fluorine
purifying hydrogen and helium
separating hydrogen from coke oven gas
ammonia and methanol synthesis
upgrading of natural gas
other extremely low temperature processes.

Put LINDE's more than 50 years' experience in gas separation techniques to work for you. Write Dept. M-13, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

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Industries that regularly require large quantities of oxygen or other atmospheric gases can obtain those they need from a LINDE plant on their own sites. The oxygen plant illustrated—built, owned, and operated by LINDE—is at a plant of one of the nation's largest chemical processors.

from 160 to 180 F.—**Union Carbide Plastics Co., New York, N. Y.** 66B

Vinyl-Coated Aluminum

For house siding with a 10-yr. guarantee against blister, crack, craze.

A completely new type of house siding made of vinyl-coated aluminum retains its durable finish and attractive appearance through rigorous weather for years without requiring repainting.

The side is coated with a special formulation made with Geon vinyl resin supplied by B. F. Goodrich Chemical Co. Both sides of the aluminum are coated before the siding is fabricated. The metal then can be formed, bent, punched and even applied to the house without affecting either the appearance or performance of the vinyl finish.

The enamel-like Geon coating—called Superclad—is by Sherwin-Williams. Durability is such that the manufacturer warrants the finish against blistering, cracking or crazing for ten years.

Available in white and pastels, the siding panels come in 10-ft. lengths with 8-in. exposure.—**Hastings Aluminum Products, Inc., Hastings, Mich.** 68A

Acrylic Resin

Designed for auto finish, also works well on plastics, wood, fabric.

New acrylic resin, Acryloid A-21, is a clear, colorless, rapidly drying, hard polymer solution. Although developed primarily for automotive finishes, it has many other applications in clear and pigmented coatings on metal, wood, plastics and fabric.

Since it can be used in both air-drying and baking finishes, its utility ranges from metal finishes for appliances and furniture to the highly specialized fields of metallized plastics and top coats for vinyl films.

Acryloid A-21 is a relatively hard polymer so that plasticizers are required i nsome applications. It is compatible with a wide range of monomeric plasticizers. Those with which most experience has been gained are butyl benzyl phthalate and dibutyl phthalate.

Physical Constants

Solids	30% ± 0.5%
Solvents	90/10:Toluol/Butanol
Viscosity	N-U (Gardner-Holdt at 25 C.)
Color	Colorless and clear
Wt./gal.	7.85

Its outstanding properties for automotive finishes include: excellent durability, easy pigment dispersion, adhesion to primers, adhesion to lacquer and enamel top coats, ease of polishing, polished gloss, road stain resistance, humidity resistance, humidity-cold cycling and gasoline resistance.—**Rohm & Haas Co., Philadelphia.** 68B

Detergent

Low cost nonionic is ethylene oxide adduct.

A new nonionic featuring good wetting properties is now available at one-third the cost of competitive products.

Product, called Pronon 505, is slated for use in formulations calling for strong wetting to improve detergency. It is expected to find use in laundry compounds, floor scrubbing compounds, etc.

It is described as an ethylene oxide adduct of an unnamed aliphatic alcohol: A free flowing, opaque liquid, 100% active, nonionic of the ether linkage type.

Company reports that during a series of syntheses of ethylene oxide adducts, it discovered that the compounds of this aliphatic alcohol underwent a rapid change of physical properties between 3 and 5 moles of ethylene oxide added. General wetting and surface tension-lowering properties remained good while cloud point and foaming properties changed.

Pronon 505 has a canvas disk wetting time of 5 sec. compared to conventional 10 mol nonyl phenol compounds which have a canvas disk wetting time of 7 min. under the similar conditions of room temperature and 0.1% concentrations.

Selling at 35¢/lb. in drum lots, it's the lowest cost compound available with such good wetting properties for negatively charged surfaces. The closest available compound is the dioctyl ester of sodium sulfosuccinic acid which sells at about $1/lb.—**Process Chemicals Co., Los Nietos, Cal.** 68C

BRIEFS

New copolymer of styrene and methyl methacrylate called Zerlon 150 is the first member of a totally new family of plastic molding materials. The product is a thermoplastic with excellent clarity, processability, weatherability, toughness, strength, heat resistance and light stability. Sold in crystal form only at 49 to 50½¢/lb., it is expected to find its biggest markets in the automotive, appliance and sign fields.—**Dow Chemical Co., Midland, Mich.** 68D

Higher density ammonium nitrate fertilizer called Lion E-2 takes 20% less space, is dust free, hard prill. It retains its prill uniformity and does not cake during storage, even under the most adverse conditions.—**Monsanto Chemical Co., St. Louis, Mo.** 68E

Epoxy potting compound offers extreme resistance to thermal shock, withstanding cycling to −90 F. without failure. Called Epoxylite 2151, it is said to owe its shock resistance to a molecule especially designed for low-temperature service by applying the stereospecific concept of thermoplastic technology to epoxy research.—**Epoxylite Corp., El Monte, Calif.** 68F

For More Information . . .

about any item in this department, circle its code number on the

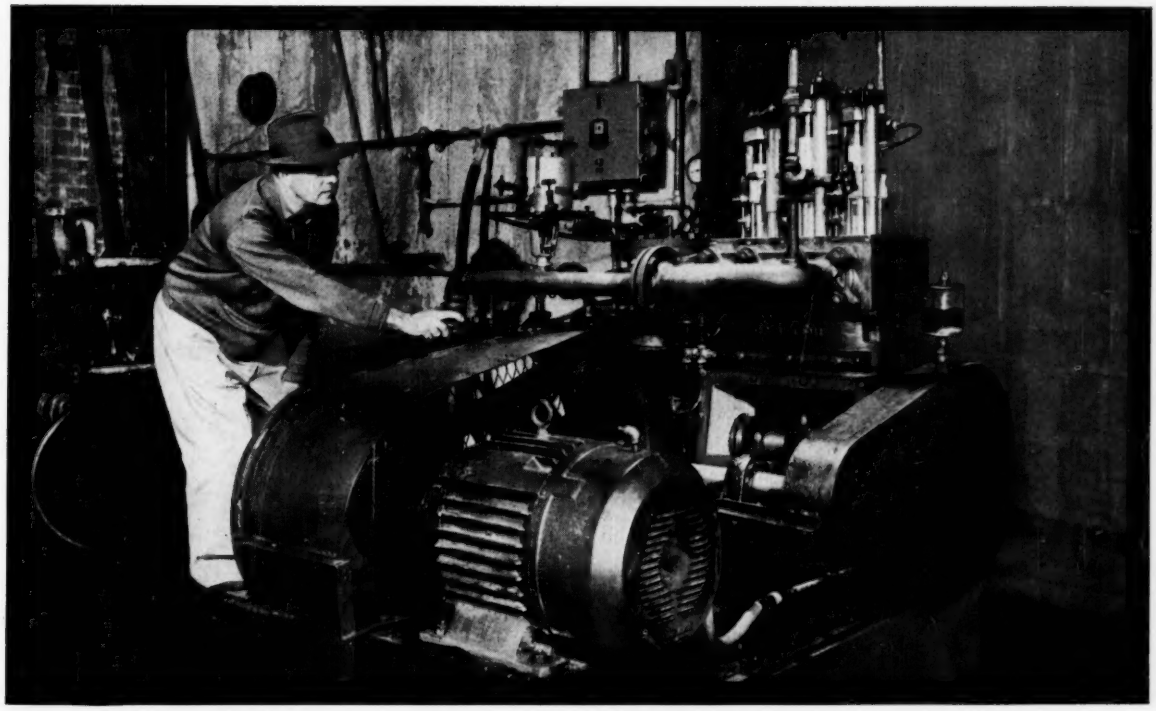
Reader Service

postcard (p. 165)

JACQUES WOLF & CO. SOLVES PROBLEM:

How to maintain constant, undeviating pressure in the production of highly corrosive chemicals

Precise, non-fluctuating pressures must be maintained in continuous processes at the Carlstadt plant of Jacques Wolf & Company. Erratic pressure caused by drop in volumetric efficiency could ruin an entire batch of costly material.



How Jacques Wolf solved the puzzle: Looking for an answer to the problem of holding constant pressure, plus that of increasing production, Jacques Wolf called on Aldrich. Aldrich engineers designed a pump which provided the proper corrosion resistance, fluid velocity and wear characteristics to insure dependable, continuous operation.

Result: After five months of use, the Aldrich Triplex Pump has met all guarantees and proven itself capable of continuous operation. Working 24 hour days, 6 day weeks, the Aldrich Triplex Pump provides the necessary pressure without fluctuation, efficiently handling both alkaline and acidic materials.

We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH

DEVELOPMENTS . . .

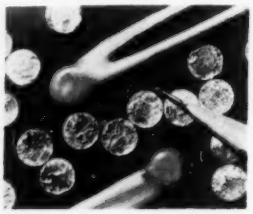
PROCESS EQUIPMENT

EDITED BY C. C. VAN SOYE

Latest Developments

Plasma Spraying Service

Applies coating, fabricates shapes for temperatures above 5,000 F. *74A*

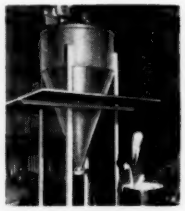


Thermistors

New family has positive temperature coefficient of resistance. *144A*

Extractor

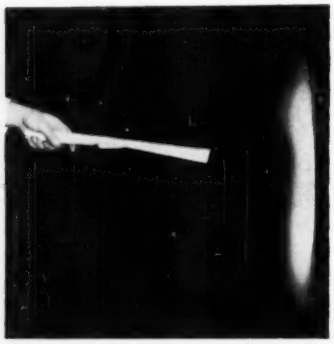
Tailor-made units handle 20 cc./min. to 20 gpm. *145A*



Blender

Uses air to blend free-flowing granular materials. *72E*

Page number is also Reader Service Code Number



Burner

Distributes heat at right angles to centerline.

An unburned, rolled sheet of paper in the above photograph shows that local hot spots in front of a new burner are nonexistent—the flame produced has no forward velocity. Burners of this variety may find use in heating direct-fired exchangers, in salt bath furnaces and in other applications requiring the absence of flame impingement or hot spots.

Known as the Series 4832 Flat Flame Burner, the unit comes in six sizes, with capacities ranging from 234,000 to 2,620,000 Btu./hr. at 16 psi. air pressure. — **The North American Mfg. Co., Cleveland, Ohio** **70A**

Paddle Feeder

Stops non-uniform delivery of solid materials.

A newly designed rotary paddle feeder for small granular material is claimed to eliminate formulation inaccuracies by assuring constant, uniform delivery. Several paddles revolving around a stable drum within a housing prevent materials pile-up, and also provide the claimed self-cleaning feature.

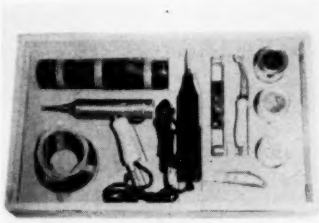
Construction permits installation directly below bin openings, with no loss of floor space. Maximum capacity is 30 cfm.— **Richardson Scale Co., Clifton, N. J.** **70B**

Flash-Point Recorder

On-site monitor for refining operations.

A new continuous flash-point recorder will automatically take samples from a process stream at three-minute intervals, run a flash test on each sample, and record the results. All results correlate with the manually performed ASTM test to within ±2 deg. F.

Range of operation is from 80 to 190 F. Except for the recorder, which can be located in some remote area, the instrument is safe for use in Class I, Group D hazardous locations.— **Precision Scientific Development Co., Chicago, Ill.** **70C**

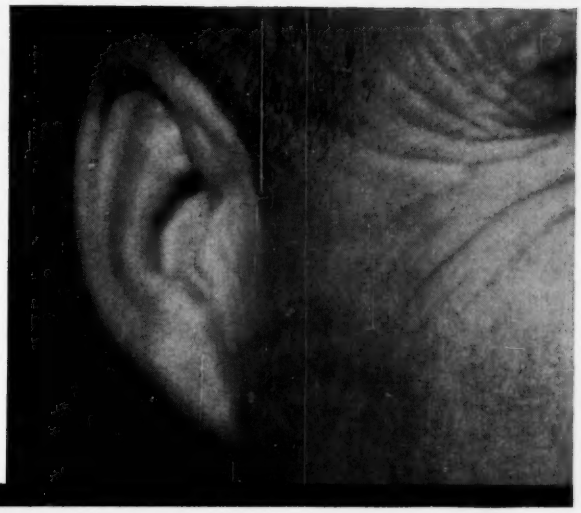


Repair Kit

Mends PVC-lined acid-handling equipment.

Do it yourself. These three, often-used words now apply to the maintenance of polyvinyl chloride linings on acid-handling equipment. A new repair kit including all tools required for PVC repair work has just been introduced by a company specializing in tank linings.

Each kit includes a spark tester, heat-resistant Permagun, dual seamer, stitcher, utility knife, and supplies of cement, patching and seaming



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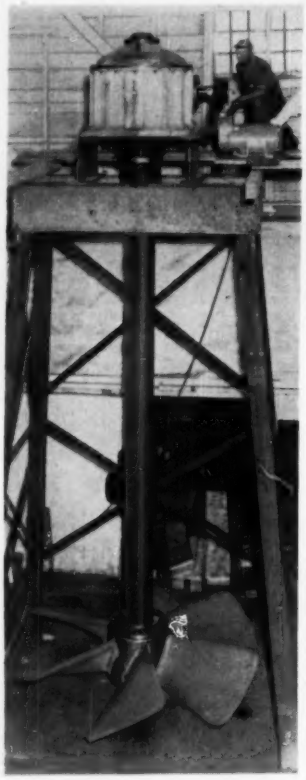
materials. Kit cost is $159.—**Perma-Line Rubber Products Corp., Chicago, Ill. 70D**



Man's Not a Midget, Agitator's Just Large

Denver Equipment Co. is now producing huge propeller agitators that are double the size of any it previously turned out. Machine work is under way on a unit having a propeller blade span of 10 ft.; until recently, DECO's biggest models had 60-in. propellers.

Shown above is a "middle-size" unit having 96-in. blades. It will soon be churning process fluids in a 20 x 25-ft. tank at an alumina plant. Another 96-in. model is destined for use in an iron ore extraction process.

Company officials claim that the large propellers will operate successfully in both heavy and dilute slurries.—Denver Equipment Co., Denver, Colo. 72A

Weighing Attachments

Two manufacturers attach scales to trucks.

Introduction of a complete scale system into the design of a standard platform-lift truck promises to increase the truck's time- and labor-saving values. Not only does the combined unit make unnecessary all travel to and from a centrally located weighing device, but it also eliminates the need for determining and using truck tare weights.—**Detecto Scales, Inc., Brooklyn, N. Y. 72B**

Another manufacturer has incorporated a 5,000-lb.-capacity weighing attachment to its line of fork-lift trucks. Controls for the scale mount on the truck's steering column, within fingertip reach of the operator. The weighing mechanism mounts between the upright and fork plate. — **Clark Equipment Co., Battle Creek, Mich. 72C**

Gravity Filter

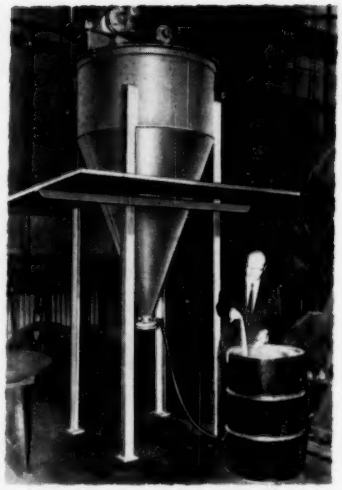
Uses no valves. Treats process water.

Completely automatic, a new gravity filter for water-treatment facilities is claimed to be far lower in cost than conventional automatic gravity filters. The unit also assures a uniform high-quality effluent because it cannot be forced; neither can backwash nor rinsing cycles be altered.

During the filtering cycle, head loss across the bed of filter media increases with collection of dirt. This causes the water level to rise in a backwash pipe until a self-activated primer evacuates the pipe's remaining air. As a result, a siphoning action takes over and pulls water through the bed in a reverse direction, thus backwashing it.

This action continues until the tip of a siphon breaker is uncovered by the tank's receding water level; then the unit resumes the filtering cycle.

Units come in diameters from 4 to 12 ft.; height is 14 ft.; maximum feed rate is 340 gpm. —**Permutit Co., N. Y., N. Y. 72D**



Gas-Activated Blender

Quickly and thoroughly homogenizes powder mixes.

First, fluidize all free-flowing solid materials to be blended. Then stir them as though they were liquids. Such is the operating principle of a new blender developed for commercial, pilot-plant and laboratory applications.

Basically, the unit consists of a vertical conical shell in which a central rotating shaft carrying a number of stirring paddles produces a definite circulation pattern.

Feed gas entering the vessel's apex induces localized fluidization. This action, combined with that of the paddles, causes the solids to flow upward in the center of the cone, to overspill at the top of the charge, and to fall back to the apex along the walls.

Since the fluidization is limited to the apex region, particle entrainment is arrested by the blanket of non-fluidized solids

For More Information . . .

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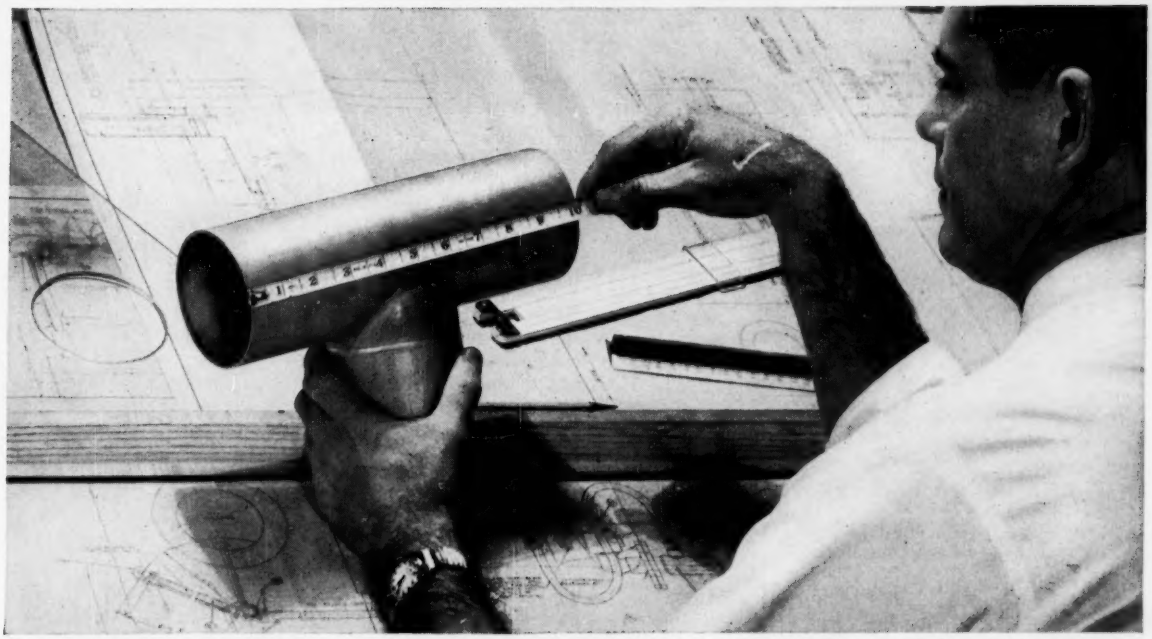
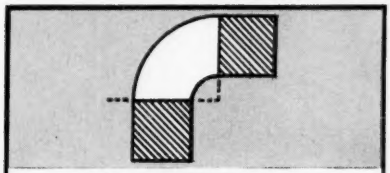


SAVINGS ARE MEASURABLE...START TO FINISH WITH *LONGER LENGTH* SPEEDLINE FITTINGS



HERE'S HOW YOU CAN CUT PIPING COSTS

A conventional 90° elbow is shown inside the dotted line. The shaded areas indicate the extra length you get with a Speedline fitting—at no extra cost. For example, on a 3" Speedline Elbow it means 4" more pipe. Thanks to the longer length of all Speedline fittings, all types of joints are made more easily . . . cost less . . . than with conventional fittings. Make your own comparisons.

For location of Authorized Distributor nearest you, see Speedline listing on page 593 in Chemical Engineering Catalog.

With this 3" Speedline Tee you get 3¼" *"more length"* at no extra cost. Speedline's *tangential feature* cuts costs and design detailing, too . . . lets you select the best joint to meet assembly requirements . . . means more clearance for welding and easier pipe aligning. Flange where you want to, weld where you want to . . . *any* type joint can be used on *any* or *all* ends of a Speedline corrosion resistant fitting!

Greater flexibility of Speedline long length fittings adds up to faster assembly and *lower installed costs*—even for the most complex process piping system. And, of course, Speedline corrosion resistant fittings *cut material costs two ways:* they give *more* pipe length per fitting and they facilitate use of economical *light wall stainless* steel pipe.

Before you plan any new installation or system addition, investigate the many advantages of Speedline's *tangential* feature. Write for Speedline Catalog showing how you save with the complete line of Speedline fittings.

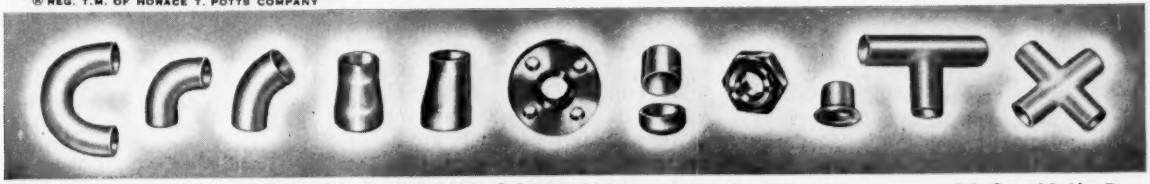
Speedline®

® REG. T.M. OF HORACE T. POTTS COMPANY

STAINLESS STEEL FITTINGS

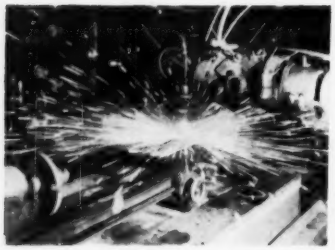
SPECIALLY DESIGNED FOR SCHEDULES 5 AND 10 PIPE

P-800



Manufactured by HORACE T. POTTS COMPANY • 500 E. Erie Avenue • Phila. (34), Pa.

in the top portion of the charge. — **Colonial Iron Works Co., Cleveland, Ohio.** 72E



Plasma Spraying Service

For high-temperature materials of construction.

Custom services for fabricating shapes and applying coatings that will withstand temperatures above 5,000 F. are now being offered by the Linde Co. The photo above shows Linde's new Plasma Arc Torch coating stainless steel onto an aluminum plate. Application of successive coatings of such materials as tungsten, molybdenum or zirconium on a spinning mandrel, followed by mandrel dissolution, can yield a wide variety of ultra-hard, heat-resisting shapes.

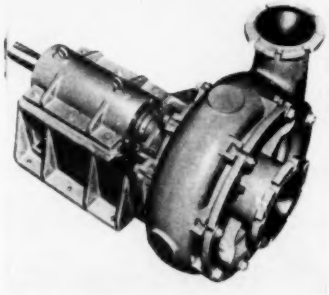
In operation, either wire or powder feed metal enters the torch and melts in the intense heat (15,000-30,000 F.) of a constricted electric arc. A continuous flow of inert gases carries plastic or fluid metal particles away from the torch, and deposits them on the working surface at near-sonic velocities. Jets of carbon dioxide then cool the product.—**Linde Co., Div. of Union Carbide Corp., New York, N. Y.** 74A

Spectrophotometer

New infrared instrument just introduced.

With its new infrared spectrophotometer called the IR-7, Beckman reports that for the first time it has run the full 32-ft. spectrum for ammonia. The new instrument is a fully automatic, continuous-scanning device of the grating type.

IR-7 utilizes a replica grating in conjunction with a sodium chloride prism, providing three times as much resolution as is possible with conventional double-beam, double-prism spectrophotometers. Other features include variable scanning speed, repetitive scanning and horizontal strip-chart recording with variable abscissa and ordinate expansions. — **Beckman/Scientific & Process Instrument Div., Beckman Instruments, Inc., Fullerton, Calif.** 74B



Solids Pump

For moving slurries containing solid lumps.

Designed to handle fluids containing random-size, highly abrasive solids, the Model CK solids pump may find considerable application in the process industries. Typically, the 6-in. low-speed centrifugal model will efficiently handle solids up to 4⅛-in. diameter.

Model CK comes in five sizes: 4, 6, 8, 10 and 12 in. Materials of construction include semi-steel, cast steel and manganese steel.—**Morris Machine Works, Baldwinsville, N. Y.** 74C

Steam Control System

Pulsations reduce resistances to heat flow.

Known as the Velocity Steam System, a new control unit increases heat transfer rates in process equipment, according to the manufacturer. Two of the other functions of the unit, which installs between any boiler and its feed pump, are to return pre-heated condensate, along with necessary deaerated makeup water, to the boiler at 300 F., and to automatically purge the entire system of air and gases.

To increase heat transfer rates, the unit causes pulsation of steam pressures throughout the system. With each abrupt drop of pressure, condensate forming on heat transfer surfaces flashes momentarily back to steam, thus breaking down the high-resistance condensate film. Net result is increased fuel economy and effective boiler capacity. — **Forse Corp., Anderson, Ind.** 74D

Fire Extinguisher

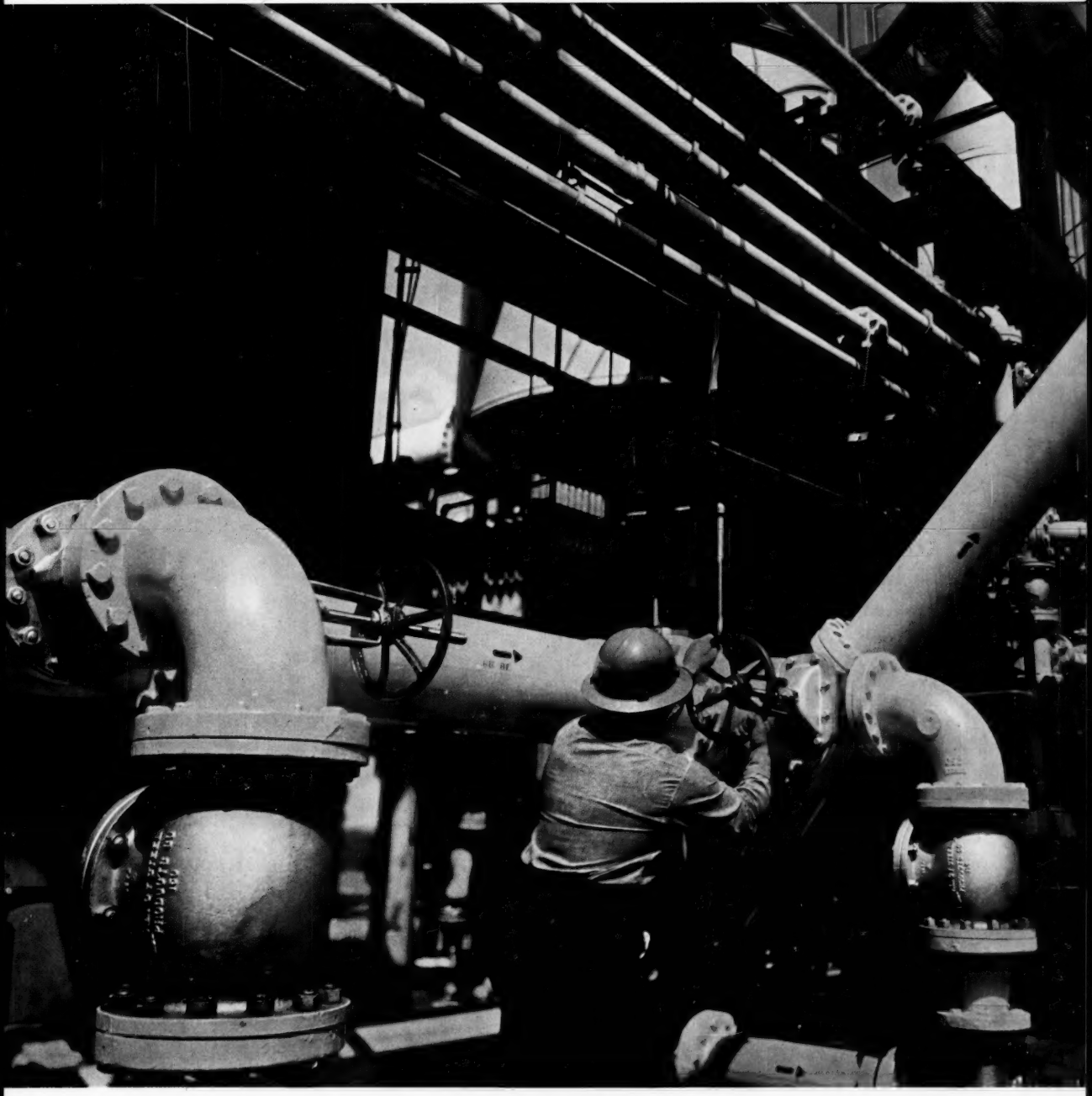
Streamlined units easy to operate and recharge.

Two new, pressurized, dry-chemical, portable fire extinguishers with 2½- and 5-lb. capacities put out as much fire as 8 and 16 carbon tetrachloride portables (1 qt.), respectively.

According to the manufacturer, their designs stress simplified, self-evident operation. Actuation of a single lever causes chemical discharge—no locking pin to remove, no valve to turn, no inverting or bumping.

Rugged pressure gages indicate at a glance whether recharging is needed. Air or nitrogen can be used to restore pressure to the operating range of 110-180 psi., if necessary.—**Walter Kidde & Co., Inc., Belleville, N. J.** 74E

Thermistors
and other equipment news
on page 144.



Aloyco Valves in General Chemical's new "dream" plant

The Aloyco Valves you see here are controlling the flow of 98% acid in the new sulfuric acid plant of General Chemical Division, Allied Chemical Corporation, at Elizabeth, New Jersey.

The plant utilizes most modern processing techniques. All equipment was chosen for its special ability to contribute to operating efficiency and long life.

For example, valves made in Aloyco 20, an alloy exceptionally resistant to corrosion from sulfuric acid, were specified for handling spent and sludge acids, as well as finished strong acid and oleum.

When you are selecting valves for corrosive service, remember only Alloy Steel Products Co. specializes in Stainless Steel Valves exclusively. Call our local representative or write us at 1301 West Elizabeth Avenue, Linden, N. J. 9.2

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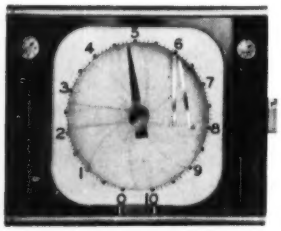
Bristol's 7-point coast-to-coast field service

Helps you from the time you start thinking instruments – through installation – for as long as the job requires



A Bristol Field Engineer is the man to call when you first start thinking about instrumentation. Located in a nearby Bristol office (they blanket the U.S. and Canada) he calls at your plant to assist you in planning your proposed installation. No obligation.

Application Engineers, specialists in the abilities and limitations of every type of instrument, and Process Specialists, experts in instrumentation techniques in varied fields can be called in where necessary. They insure you the right instrument, installation and operation for your specific job.

Service Engineers to keep your instruments operating perfectly are "on call" often within a few hours. They install, check and adjust instruments in your plant.

Periodic Check-up Service at regular intervals is also available.

Bristol's Instrumentation Schools for customer engineers help train your own technicians in instrument operation and maintenance.

Factory Repair Service at San Francisco, Los Angeles, Chicago, Houston, Waterbury and Toronto has all facilities, parts, experience to properly repair, recondition and remodel Bristol instruments. Each instrument reconditioned carries a new instrument warranty.

Fast Parts Service is assured by the Bristol practice of stocking service parts that may be needed in emergencies in all 38 Branch offices. You get fast action from a near-by source.

These big extras you get with Bristol instruments are good reasons—over and above outstanding basic instrument quality—why every Bristol installation gives such high accuracy and precision performance over an extremely long service life. To find out more about Bristol instruments or service, write: The Bristol Company, 109 Bristol Road, Waterbury 20, Conn. B-17

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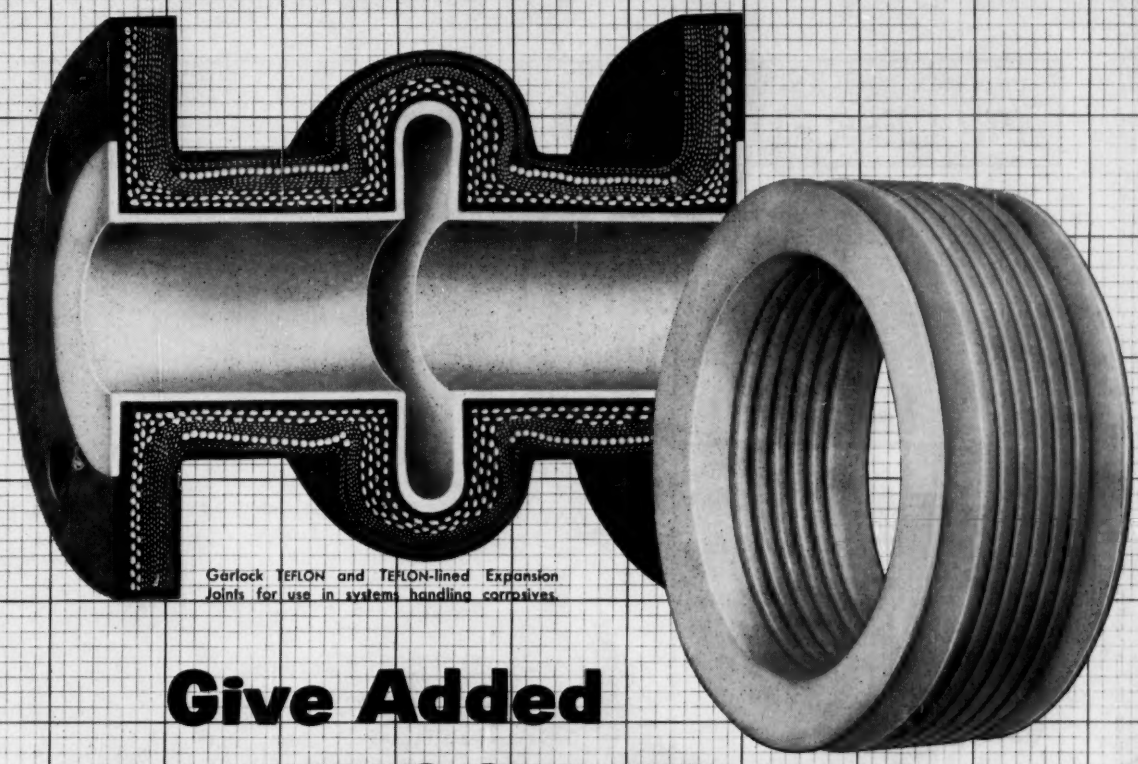
MORE OF THE GARLOCK **2,000**

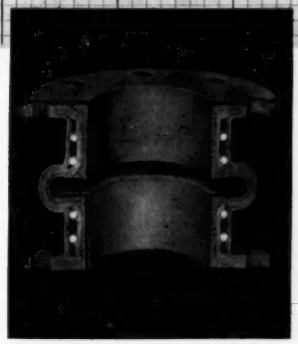


Garlock TEFLON and TEFLON-lined Expansion Joints for use in systems handling corrosives.

Give Added IMPACT RESISTANCE to costly piping

Garlock Expansion Joints protect your costly piping from damage caused by shock, vibration, expansion or contraction. TEFLON Expansion Joints are recommended when corrosives such as acids, caustics, or solvents are being handled. TEFLON-lined Expansion Joints are used in higher pressure systems handling corrosives. All-rubber expansion joints are recommended for water, mild acids, mild caustics, air or exhaust steam at temperatures up to 180°F. The right size and type is available for handling any liquid or gas.

Expansion joints are another important part of "The Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line. Ask your Garlock representative for his unbiased recommendations or write for Expansion Joint Folder AD-137.



Cutaway of Garlock All-Rubber Expansion Joint shows steel reinforcing rings which vary in number with size. These Joints are available in sizes from 1¼" dia. to 18 feet in diameter.

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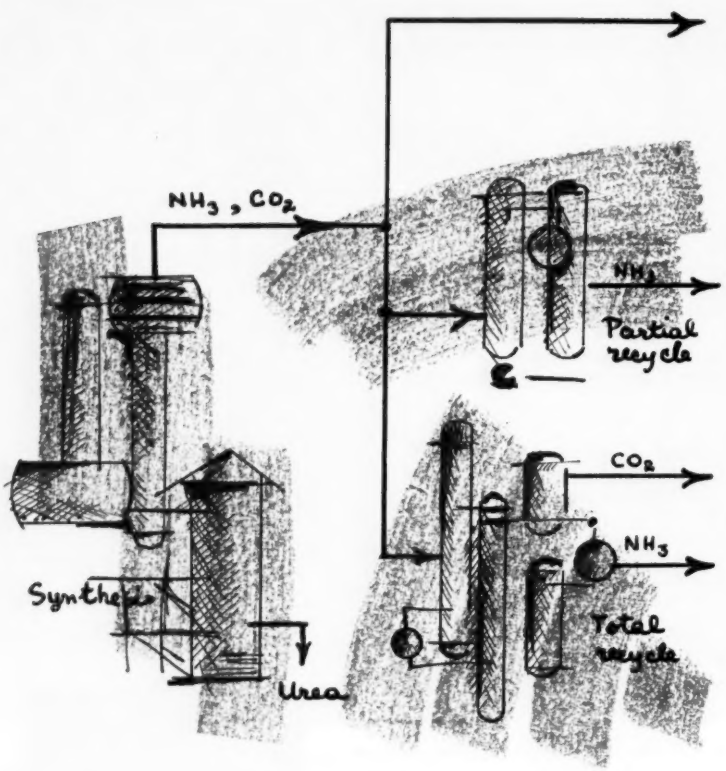
PRACTICE . . .

PROCESS FLOWSHEET C. S. CRONAN



Off-gas can go into solid or liquid fertilizers, or nitric acid synthesis.

Partial recycle system furnishes NH_3 for fertilizers or for recycle to synthesis.

Total recycle system returns unreacted NH_3 and CO_2 to the urea synthesis section.

Three Versions of Inventa Urea Process Operating

Having three flowsheet variations in commercial operation—zero, partial and total recycle—is the distinguishing feature of the Inventa-Vulcan urea process developed by Holzverzuckerungs AG. (Ems, Switzerland) and engineered by Vulcan-Cincinnati, Inc. Totaling up plants on stream, under construction and under contract, the Inventa-Vulcan process will account for 400,000 tons/yr. urea output within the next 18 months.

Two once-through plants recently came on stream in the U. S.: Hercules Powder Co., Hercules, Calif. (60 tons/day); Southern Nitrogen Co., Savannah, Ga. (30 tons/day). A third "large-scale" once-through plant is under contract for Mississippi Chemical at Yazoo City, Miss.

Standard Oil of Ohio brought a 120-ton/day partial recycle plant on stream in 1956 at Lima, Ohio, to make both fertilizer solutions and prilled product. One overseas total recycle plant is operating and one is being started up. Two more foreign total recycle plants are under construction,* accounting for another 790 tons daily capacity.

▶ **Why So Popular?**—Asked this question, Vulcan's Associate Manager of Engineering Mark Swetland points to the simplicity and versatility of the flowsheet.

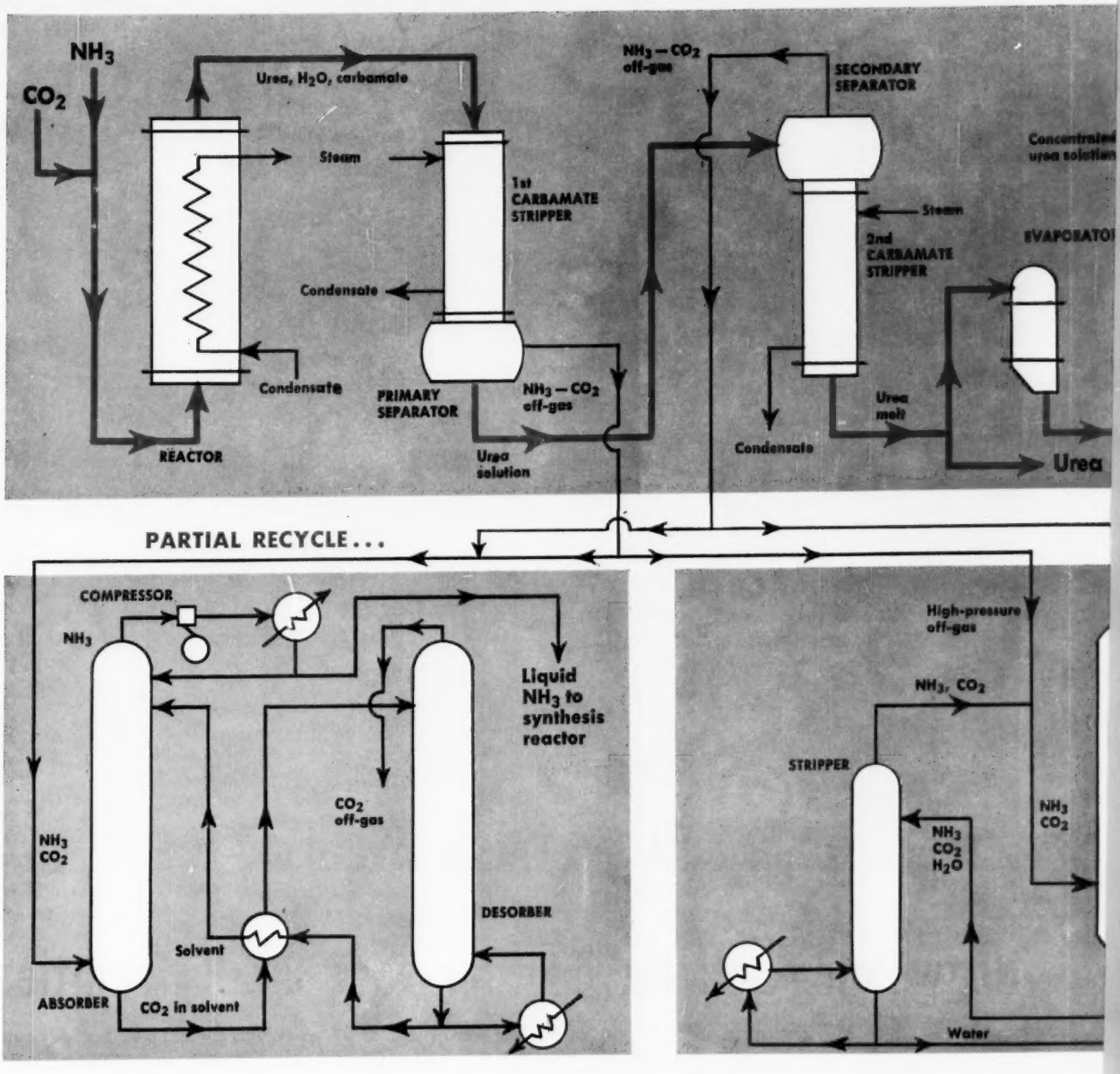
Process is based on the standard NH_3-CO_2 synthesis

$$2\,NH_3 + CO_2 \rightleftarrows NH_4COONH_2 \rightleftarrows NH_2CONH_2 + H_2O$$

forming ammonium carbamate, urea and water. Unreacted NH_3 and CO_2 is either recycled or used elsewhere in the plant. Urea solution goes to make fertilizer

* On steam: Holzverzuckerungs AG, Ems, Switz. Being started: Taiwan Fertilizer Co., Formosa. Under construction: Plants for Republic of Korea and Government of Pakistan (Pakistan plant designed by Inventa).

Unfold Flowsheet



solutions, or prilled, crystalline or flaked product. Process eliminates internal recirculations and recompressions.

And, points out Swetland, plants are easy to operate, keeping labor requirements at a minimum. Full-scale plants have been started up in a matter of hours.

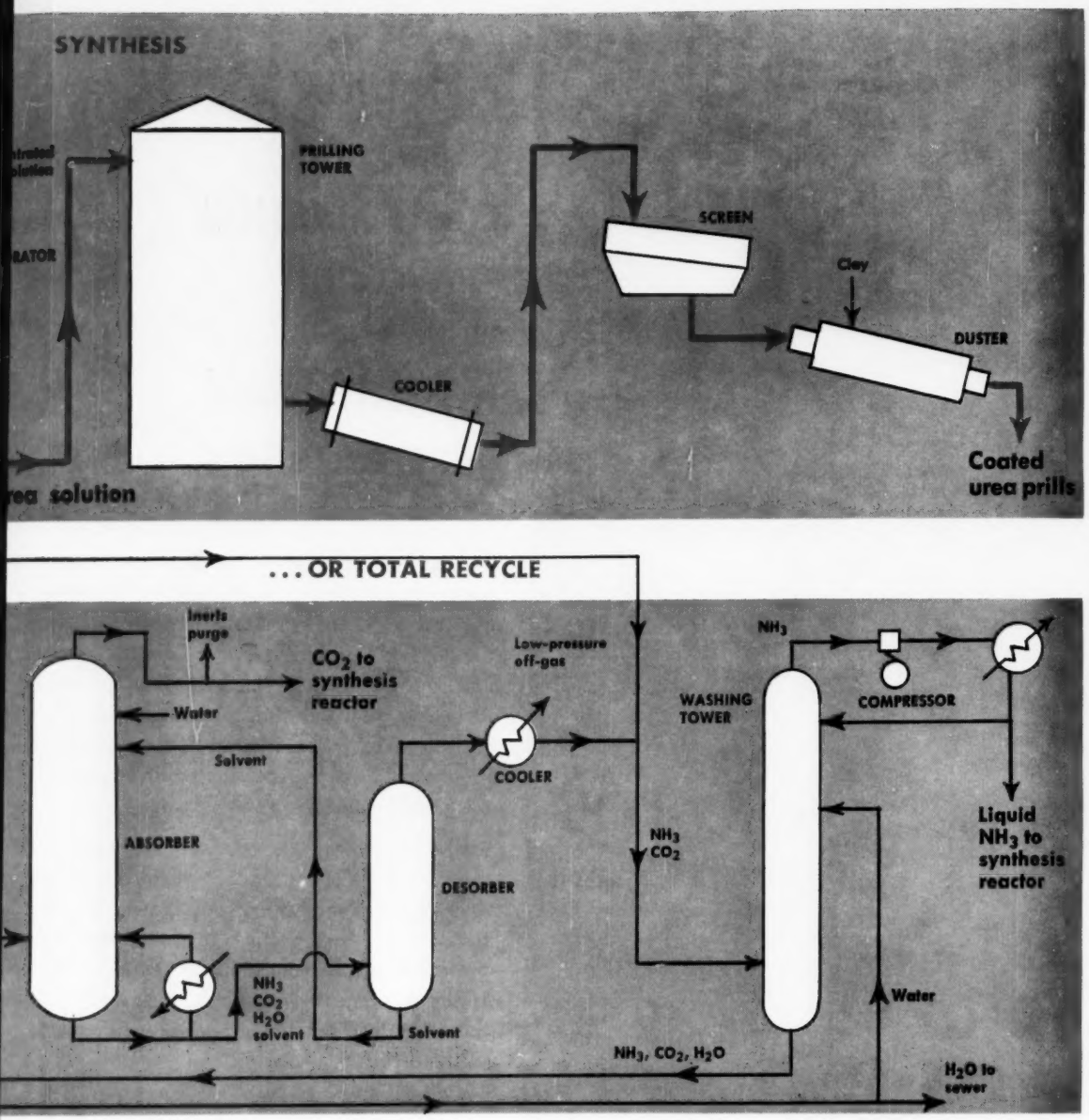
Typical raw material requirements are shown in the table on p. 50. Mol ratio of NH_3 to CO_2 in feed stream is usually around 2-3:1 and can be varied to suit circumstances at individual plants.

► **Alloy Beats Corrosion** — Corrosion, the specter hanging over all urea plants, is successfully combated in Inventa plants by an undisclosed alloy, fabricated to Vulcan's specifications.

Used in reactor lining and in a modified form in associated piping, alloy boasts a life of 10-15 years. And a special Inventa alloy utilized in plug and seat of let-down valves (which suffer the worst beating in the system) gets credit for extending valve life from 3-6 months to 14-18 months.

► **Which Version to Use?**—Swetland answers that question by lining up the pros and cons of each flowsheet.

The once-through (zero recycle) plant gives an NH_3-CO_2 off-gas that is good for neutralizing nitric, sulfuric and other mineral acids, or for nitric acid synthesis or ammonia solutions. Capital investment and operation and maintenance costs are lowest for this plant.



But for this unit to be economical, three conditions must be met: (1) Job must exist for the NH_3 off-gas, (2) Job must tolerate presence of CO_2, (3) CO_2 must come to urea synthesis plant at essentially no cost.

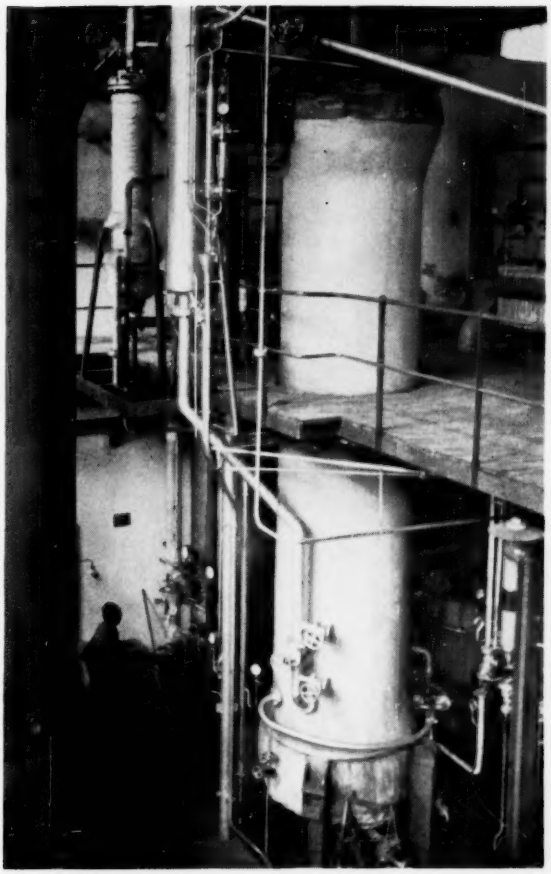
▶**Total and Partial Recycle**—Total recycle is dictated where there is no use for NH_3 off-gas, or where CO_2 has a solid dollar-value. In this case, the added investment and operating costs of recovery equipment are justified.

Partial recycle is designed for mixed circumstances where amount of ammonia needed elsewhere in the plant is less than the amount available from the urea unit. Situations like this arise when market for ammonia solutions or other nitrogen products runs behind demand for urea. Partial recycle makes urea capacity independent of associated plant operations.

▶**Take NH_3 and CO_2**—Ammonia and CO_2 at 2,400-3,000 psi. are piped to the alloy-lined synthesis reactor. Reactor is water-cooled by an internal tube bundle.

Exothermic reaction at 320-375 F. gives a solution of urea, ammonium carbamate and water. Temperature control, provided by water cooling, generates steam that can be used in the following carbamate stripping steps.

Urea melt from reactor drops across a let-down valve to 50-300 psig. and is piped to the first carbamate stripper—a shell-and-tube heat exchanger combined with a gas-liquid separator. Steam circulating on the



REACTOR in Inventa process is water-cooled via internal tube bundle. (Photo shows Ems, Switzerland plant.)

PRILLING TOWER (left) dominates the 270-ton/day total recycle plant in Korea built by McGraw-Hydrocarbon.

TOWERS of the Korean plant's recycle system are in the foreground. Synthesis section is in the background.

shell side decomposes ammonium carbamate in the tubes to NH_3 and CO_2. Stream separates into gas and liquid phases in the primary separator.

► **Urea Finishing**—Urea solution from separator is pumped through a second let-down valve to a second stripper where remaining carbamate in the melt is decomposed. Urea melt from stripper, an 80-90% aqueous solution, goes either directly into fertilizer solutions or is processed into prills, crystals or flakes.

To make prills or flakes, solution is concentrated to more than 99% solids in a turbulent falling-film evaporator. Hold-up time at required evaporation temperature is a matter of a few seconds to minimize biuret formation. From evaporator, urea drops through a prilling tower followed by cooling and screening steps.

► **Rescuing NH_3 and CO_2**—In partial recycle scheme, most of the off-gas (in one case 85%) from the two separators is fed to an absorption column where CO_2 is removed from gas with an unspecified absorbent.

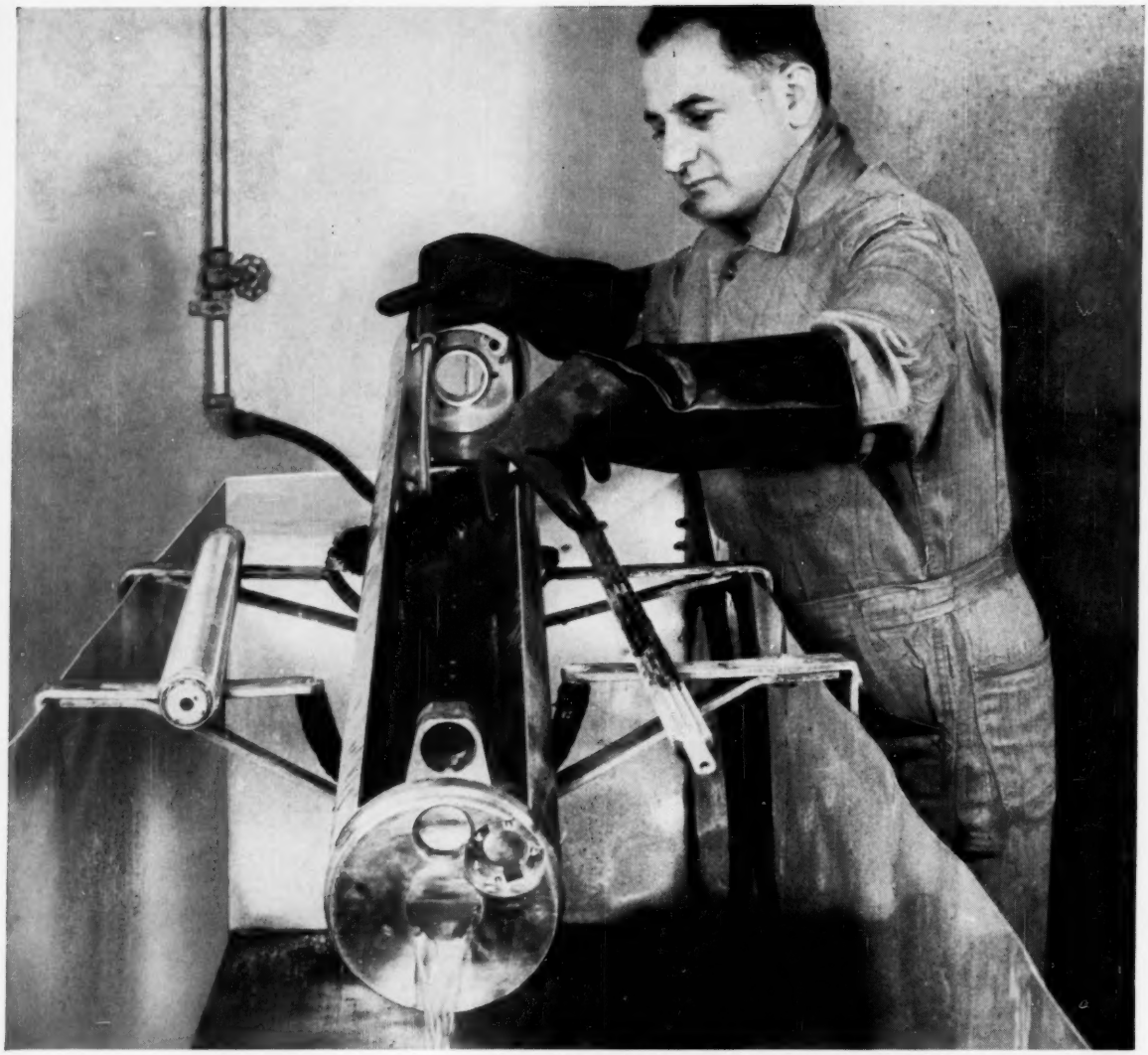
Ammonia overhead is liquefied and can be recycled to synthesis reactor or used in other parts of the plant. Two-thirds of the total NH_3 in the off-gas is recovered in this case. Bottoms from absorber goes to a desorber still where absorbent is recovered, giving an overhead gas of CO_2 with some NH_3.

In total recycle plants, high-pressure (50-300 psig.) off-gas from primary separator flows up absorption column against an unidentified solvent. Overhead CO_2 stream recycles to reactor.

Bottoms from absorber, consisting mostly of NH_3 and solvent, is pumped to the desorber where solvent is recovered and the ammonia-rich overhead gas flows to washing tower. Joining this stream is the low-pressure off-gas from the secondary separator. This gas stream is washed with a countercurrent flow of water. Overhead is essentially pure ammonia which is liquefied and recycled to reactor. Water from bottom of wash tower is stripped free of CO_2 and NH_3 in a fourth column.

Vulcan has developed a refined version of this total recycle system that will be employed in future plants. Firm won't go into the details of its improvements at this time, however.

For more on urea see p. 44.



A control rod drive housing being rinsed at Fairchild Camera and Instrument Corp. Radiological Decontamination Laboratory, Syosset, L. I., N. Y.

Ion exchange helps save "hot" reactor mechanisms from the nuclear cemetery

When valves, pumps, heat exchangers and other parts used in or with nuclear reactors became sluggish or clogged, they used to be taken out and buried in the ground because they were radioactive . . and replaced by new parts. This ran into money. A single control rod drive mechanism, for example, costs $30,000.

Now radioactive contamination is actually scrubbed off and rinsed away so that parts can be refurbished, reassembled and re-used . . at a fraction of their replacement cost.

Radioactive rags, brushes and cleaning fluids used for decontaminating are put in special containers and disposed of through licensed agencies.

But the problem of what to do with the contaminated rinse water is easily solved at Fairchild by their Permutit Nuclear Purifier. Each refill of 3 cubic feet of Permutit ion exchanger resin in this unit safely decontaminates thousands of gallons of rinse water!

Other nuclear applications where Permutit ion exchange is employed: concentration of uranium from ore, demineralizing reactor coolant water, treatment of radioactive wastes and purification of heavy water.

Permutit's nuclear experience is at your service. Write to the Permutit Company, Dept. CE-19, 50 West 44th Street, New York 36, or Permutit Company of Canada, Ltd., Toronto 1, Ontario.

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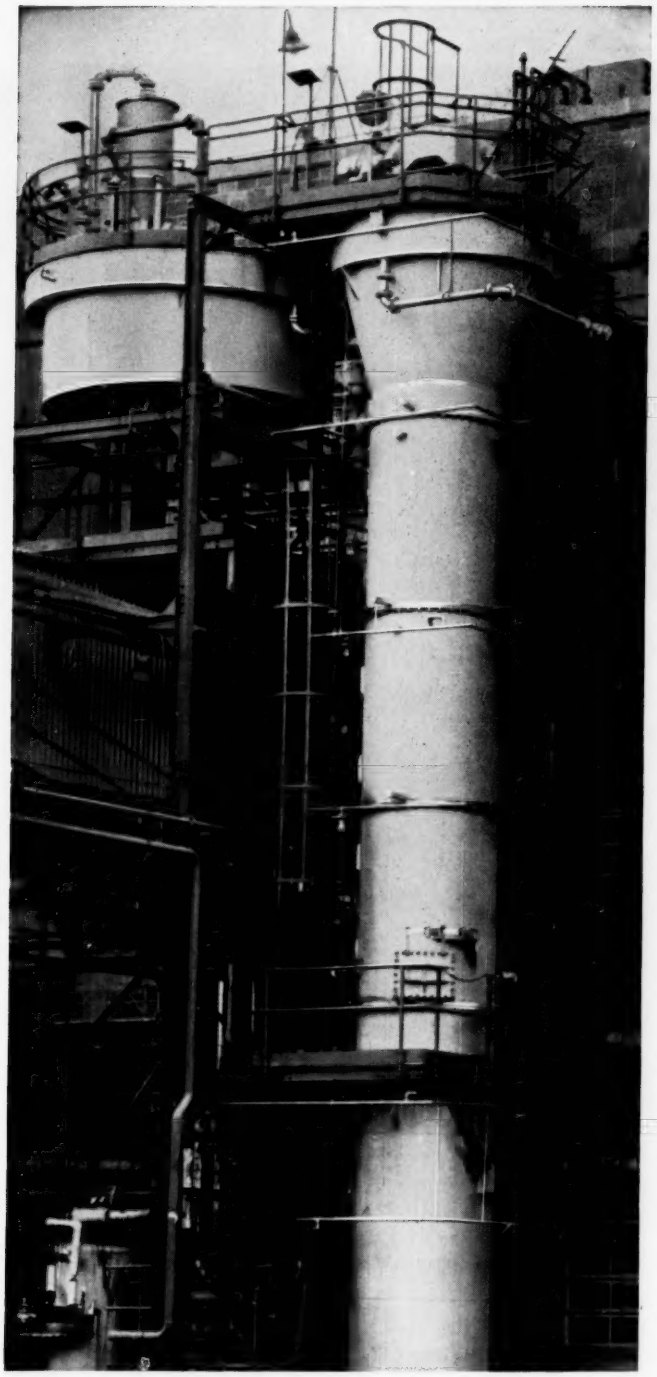

Special Manhattan Rubber Lining to resist acidified solvent and abrasive cake is installed in this extraction tower for removal of anti-biotic from mycelia cake.

PERMANENT CORROSION, CONTAMINATION PROTECTION WITH MANHATTAN RUBBER LININGS

Manhattan Acid-Proof Rubber Linings are made from thick, multiple calendered sheets of natural or synthetic rubber for utmost protection and durability. These linings expand and contract with the metal under temperature changes . . . won't harden or crack. Resistance to most acids and alkalis is as foolproof as 65 years experience and advanced technology can provide.

Every Manhattan Rubber Lining is bonded to metal so securely that they can't be separated . . . Every Manhattan Lined tank is tested under high voltage to assure flawless protection before being shipped to your plant. If the equipment *can't* be shipped to Manhattan, skilled crews will line the equipment in the field.

For permanent, positive protection for your processes *and* equipment, contact the R/M representative at the Manhattan Rubber Lining plant nearest you.

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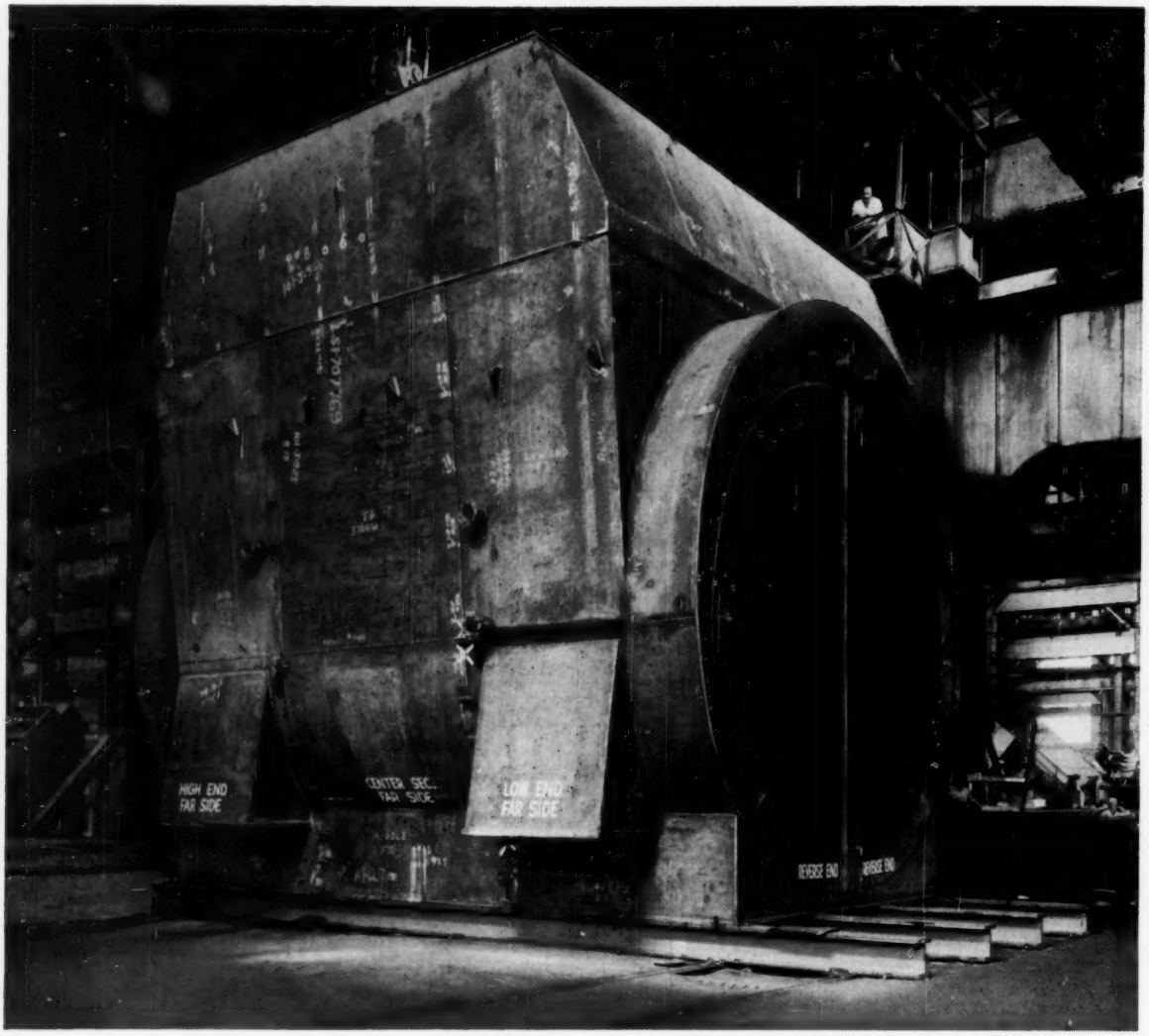

Operator of overhead crane (top, right) and workmen on shop floor are dwarfed by the enormousness of this surface condenser casing fabricated by B-L-H's Eddystone Division.

No welding job too big for vast B-L-H facilities

No welding job—not even the biggest pressure vessels—is too large for the facilities of Baldwin-Lima-Hamilton's Eddystone Division. The fabricating shop covers 15 acres and is divided into 13 bays, each 80 ft. wide and 600 ft. long.

Sheer size does not, of course, even begin to tell the whole story. From automatic tracer flame cutters to individual hand welders, we have a tool for every conceivable operation. And there is no reason for you to spend money transporting formed parts to Eddystone for welding—or completed weldments to some other shop for machining. We can handle every phase of the job—from design right through to delivery. No wonder so many companies bring the big ones to B-L-H.

Our illustrated Weldment Bulletin 7001 will give you an excellent idea of our vast facilities. You should have it in your files. For a copy, write to B-L-H Corporation, Philadelphia 42, Pa.

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Marketing Manager, Chemical Products

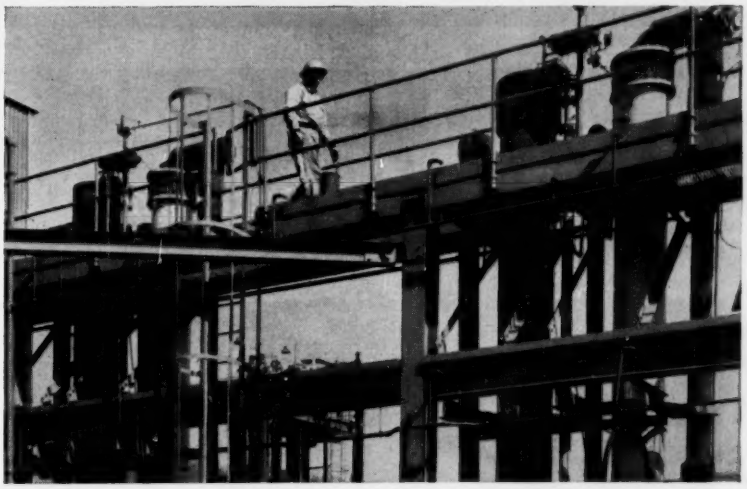
W. W. PALMQUIST

Mr. Palmquist was graduated from Yale University with a B.S. in Chemical Engineering. He has spent ten years preparing design proposals, developing new designs and improving existing designs of "Karbate" chemical processing equipment. Based on this extensive design and development background, Bill was made Manager of Sales Promotion and Development for the Chemical Products Sales Department.

For the past year, Bill has been Chemical Products Marketing Manager and is responsible for marketing the complete line of "National" carbon and graphite products and "Karbate" impervious graphite for the chemical processing and allied industries.

He is a member of the American Institute of Chemical Engineers, the National Association of Corrosion Engineers and the Electrochemical Society.

"KARBATE" CONDENSERS PROVIDE LONG, ECONOMIC LIFE IN CORROSIVE SERVICES



A bank of 4 "Karbate" condensers in an organic chemical plant.

10 to 15 Years of Trouble-Free Service

Eleven shell and tube heat exchangers have proved the excellent corrosion resistance of "Karbate" impervious graphite material. These exchangers have provided ten to fifteen years of trouble-free operation in condensing a highly corrosive *chlorinated hydrocarbon.*

Based on this performance record, additional "Karbate" shell and tube heat exchangers are planned for expansion and renovation programs in this plant.

"KARBATE" Condenser replaces Silver Condenser

To overcome the silver condenser problems of high-cost, specialized fabrication and exacting maintenance procedures, a "Karbate" shell and tube condenser was installed by a major chemical company in an *acetic anhydride* condensing application.

The unit is handling 80% *acetic anhydride* vapor at a temperature of 100° C.

The replacement "Karbate" impervious graphite unit has provided excellent heat transfer and examination after 20 months of service show it to be as good as new.

NATIONAL CARBON FABRICATES 20-FT. LONG "KARBATE" TUBE HEAT EXCHANGER

National Carbon Company was requested to replace a steel bundle in an existing all steel shell and tube heat exchanger. This presented a problem of 20-foot long tubes plus a two pass shell side arrangement. Photograph below illustrates the design of the "Karbate" baffle system used to reproduce the two pass shell feature. The 20 foot "Karbate" tube bundle was installed in the customer's existing steel shell and is now in service.

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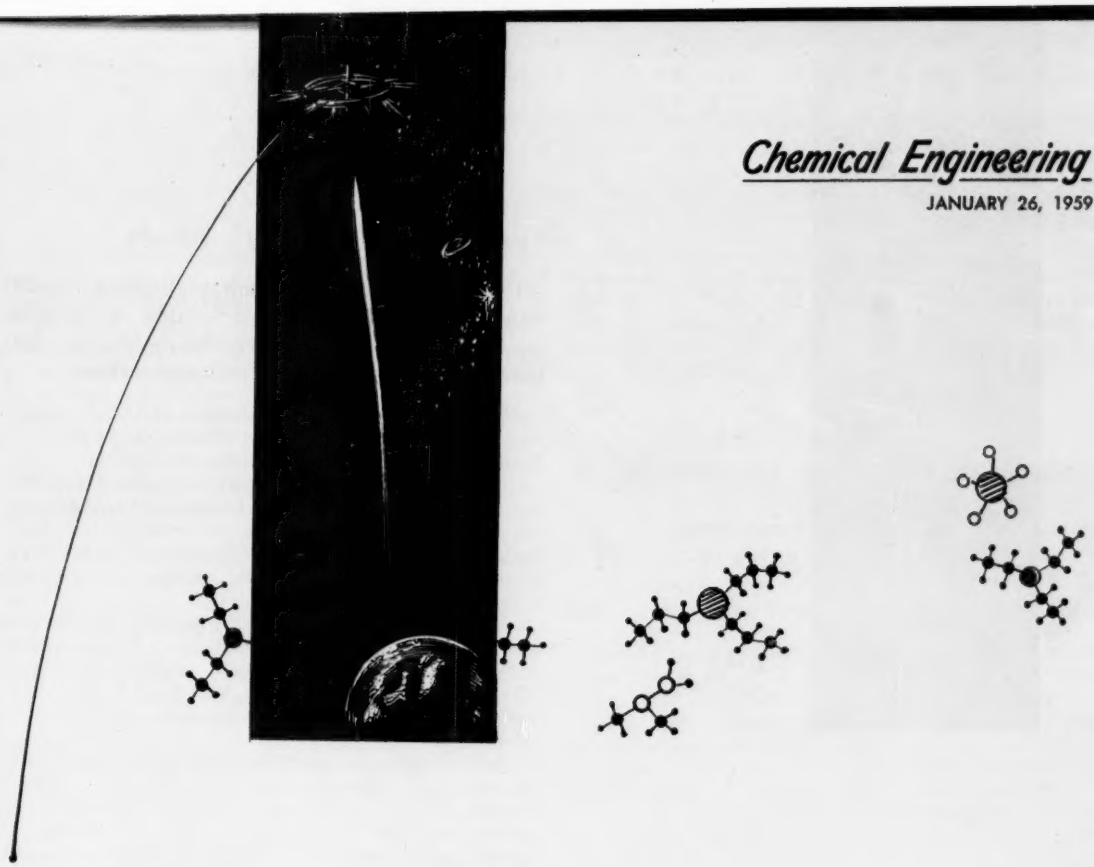


Today's Top Chemical Trends

They all point to a product specialization to meet tomorrow's extraordinary challenges.

DUANE M. FEELEY, RICHARD F. MESSING and JOHN WALSH, Arthur D. Little, Inc., Cambridge, Mass.

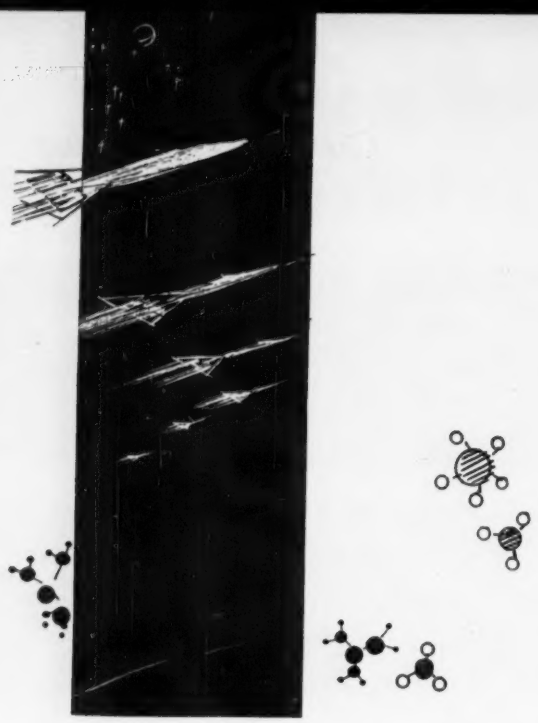
THIS is the Space Age, the Atomic Age, the Age of Plenty (for some), the Age of Tickling the Consumer Fancy to a Fairtheewell (sometimes to the point of silliness).

For chemicals and chemically processed products, though—which have a hand in all these things, from the silly to the sublime—this is the Age of Specialization.

Chemical specialization characterizes each of the important chemical trends you'll read about in the next 18 pages of this CE feature report. Specialization in plastics, fibers and other polymers, in fuels, in pharmaceuticals, in metals, in pesticides, in fertilizers.

These trends promise a day when the impossible will be possible. We *can* have a diseaseless society, fill the world's breadbasket to overflowing, put man into space, attain the ultimate in purity, make materials stronger than metals, more transparent than glass, more facile than wood, warmer than wool, more luxurious than fur.

How? By marshalling the distinctive and individual talents of a host



of chemical products. For chemical specialization will produce few super products. Rather it will produce superbly designed products, each tailored to meet a very special demand in a special situation.

We are working toward a pesticide for every pest; a fiber for every garment, every climate; a fuel for every vehicle, be it an interstellar rocket or a commuting helicopter; a plastic for every toy, every auto part, every valve, every gear, every fitting; a medicine for every ailment, from mental aberrations to athlete's foot; a fertilizer for every plant, every soil.

No longer will companies say (they will not want to, much less dare to) "This product is the end-all, the answer to anything and everything."

What they will be able to say, with greater assurance than ever before, is "This particular product can do this particular job better than anything else can right now."—ED.

Fuels Strain at Gravity's Bonds

Competition sizzles among high-energy fuels: liquids vs. solids, cryogenic liquids vs. storable liquids, monopropellants vs. bipropellants. But there's a spot for all in aircraft and rockets.

It is no secret that requirements of the space age will include the need for more efficient, more powerful fuels and oxidizers for aircraft and rockets.

Many fuels under development for rocket propulsion are classified, but it is widely known that unsymmetrical dimethylhydrazine, JP-4 (conventional jet fuel) and alcohol are now used as bipropellant rocket fuels. Fuming nitric acid and liquid oxygen are the most commonly used oxidants.

For solid propulsion systems, inorganic perchlorates are the most widely used oxidizers. Fuels in solid systems are usually elastomeric materials, such as Thiokol rubber and urethanes, which act as a fuel and serve as a binder as well. Polyesters are also widely used.

There has been much written about competition among fuel systems—cryogenic liquids, storable liquids, and solids. But as the picture unfolds it becomes more and more evident that all systems will eventually be needed in our defense program, depending upon the use for which the missile is designed.

Liquid systems offer higher specific impulses (thrust per weight flow of propellant combination) and permit fueling of rocket motors at the firing site.

Chief disadvantage of cryogenic liquids: the complex hardware and time required to fill and fire the liquid bipropellant system. Then there is the complicated series of valves, pumps, turbines, etc., required within the rocket itself. Furthermore, the cryogenic oxidant, liquid oxygen, presents serious additional logistic problems, primarily those of storage and handling.

Solid-fuel systems offer a rather great advantage in that they are stable, reliable and capable of being kept at standby readiness for long periods of time without necessity of maintaining excessive handling and firing equipment.

Chief disadvantage lies in specific-impulse ratings, which have thus far been substantially less than for liquid systems. Generally, fuel must be fabricated in the rocket casing itself at the site of manufacture; transportation of the system may be cumbersome and difficult.

Solid-fuel elements that are "cast in place" are under development now and may lessen the logistic problems involved.

One propellant system heretofore not given widespread notice is the monopropellant liquid. Monopropellants are of two types: compounds such as methylnitrate, which have self-contained reducing and oxidizing segments within the molecules themselves; and propellants consisting of solutions or dispersions of fuel in an oxidizer. Benzene plus nitrogen tetroxide is an example of the latter type.

Monopropellant systems have, for the most part, been very touchy, violently explosive, and dangerous to handle. One new monopropellant being developed

by the Naval Air Rocket Test Station is reported to have a high specific impulse and has been made and handled with acceptable safety.

This new monopropellant's nature and composition are classified. But it has been publicly stated that the raw materials are abundant and inexpensive, and that the product can be manufactured through conventional chemical processes without need for unusual toxicity or safety measures.

For the immediate future, greatest interest will probably be shown in bipropellant systems, such as those currently under test at the missile base in Cape Canaveral, Fla.

It was announced that dimethylhydrazine was used in one of the stages used to place Explorer III into orbit. Straight hydrazine is quite superior over conventional petroleum derivatives as a fuel. Unsymmetrical dimethylhydrazine (generally produced from dimethylamine, not hydrazine) has a lower freezing point, however, and is much more compatible than is hydrazine with hydrocarbons that can be used in combination with it.

Although dimethylhydrazine's high cost limits its use somewhat, superior properties as a fuel make it a material that will probably find an important place in near-term rocket development.

From its position in a periodic table, fluorine (and its derivatives) would seem to be among the most powerful oxidizers. This is borne out by the fact that in the super-high-energy range (specific impulse from 300 to 385) only ozone offers any real competition to fluorine.

Fluorine's very substantial toxicity and complex handling problems are considered severe limitations to its use. As the science of rocketry becomes more and more sophisticated, however, problems of handling toxic materials are being solved.

It seems almost certain that fluorine will eventually take its place as an important cryogenic oxidant in bipropellant rocket systems, particularly for second and third stages of multistage missiles.

Rocketdyne Division of North America Aviation conducted a good portion of the early development of fluorine-burning rocket motors. Bell Aircraft now has a contract for design of a rocket motor employing fluorine as an oxidizer. Bell's combination is understood to be fluorine and ammonia.

Elemental fluorine is currently produced by General Chemical Division of Allied Chemical, and by Pennsalt Chemicals. (Total consumption of elemental fluorine in 1957 probably did not exceed 500 tons, including all industrial uses as well as that for rocket development.)

In theory, the fuel-oxidizer combination with the greatest specific impulse is one that combines elemental fluorine with hydrogen.

Problems of handling liquid fluorine are dwarfed by the problems of handling liquid hydrogen, but the superiority of the liquid-hydrogen, liquid-fluorine rocket over other systems suggests that research on such a system would be justified.

Chlorine trifluoride, bromine pentafluoride, nitrogen trifluoride, and oxygen fluoride are all being evaluated. These fuels are of potential interest where high performance overrides cost considerations.

Within ten years, chemical propellants will probably have reached their peak of development and limits of capabilities. From that point on, more powerful systems—such as nuclear or ion-propulsion types—will be needed to meet the demand for ever increasing power in a small package.

Organometallics Work Catalytic Magic

Alkyl aluminums catalyze stereospecific polymerization of olefins. Alkyl boranes pack 40% more energy than jet fuels. Methylcyclopentadienyl manganese tricarbonyl supplements TEL.

Although organometallic products have been established commercially and in large volumes for some years, their manufacture and use has been limited to a relatively few compounds. Research work now under way promises to broaden significantly the field of application of these products, and should bring about the development of a much broader range of materials.

The keynote to interest in these products probably lies in their reactivity, particularly that of those products where the carbon atom is bonded directly to a metal. Compounds with ionic metal-to-carbon bonds are very reactive, while organometallics with covalent bonds exhibit less, but still substantial, reactivity.

Applications of larger-volume organometallics, such as tetraethyl lead and silicone intermediates, are well known. Many other products—arsenicals, Grignard reagents, and some mercury compounds like Mercurochrome—are smaller volume and technically well established.

Many derivatives of dibutyl tin dichloride are used in stabilization of vinyl resins or as polymerization catalysts. Completion by Metal & Thermit of a new facility at Carrollton, Ky., to produce these products represents culmination of a considerable period of commercial development work.

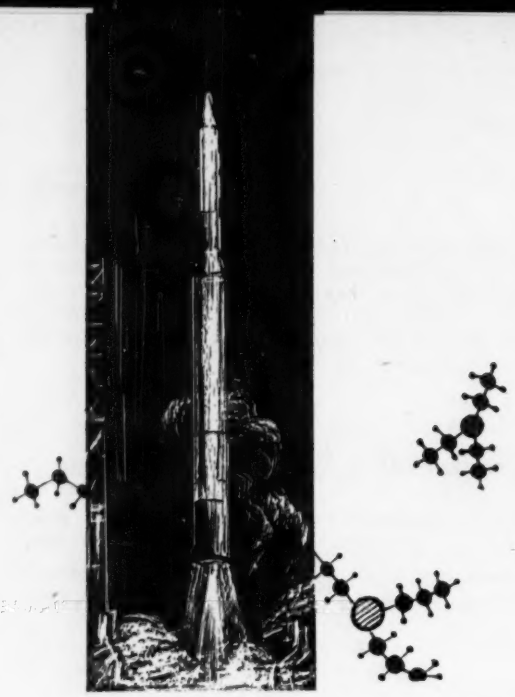
Ethyl Corp.'s development of compound AD-33X (methyl cyclopentadienyl manganese tricarbonyl) as a supplement to TEL will give organometallic products another boost in the important fuel-additive field.

Two developments have provided new impetus for growth in the organometallic field, although a number of other factors have undoubtedly stimulated interest. The first: a demonstration of the value of metal compounds as catalysts for sterospecific polymerization of olefinic materials. Ability of these compounds to orient chain structure of an organic polymer has led to tailored properties capitalizing upon inherent advantages of the material.

Triethyl aluminum seems well established for polyolefin work, and attention is being given to several other types of metal-organic compounds. The possibility of use of organometallics as catalysts in manufacture of polyisoprene forms a new commercial horizon.

Reactivity and combustion characteristics of certain organometallics have projected them into a second major new application—the area of high energy fuels.

Trimethyl aluminum and triethyl aluminum have a pyrophoric character which indicates potential use



either in mixtures with, or supplements to, jet fuel to avoid flame-out problems. Alkyl borane compounds have similar characteristics, although reactivity can be reduced by incorporation of a higher proportion of hydrocarbon in the molecule.

Construction is now well along on two major new plants to produce alkyl borane compounds for use in military aircraft. Major emphasis is being placed on air-breathing units.

In such applications the higher heating value of the boron fuel—25,000 Btu./lb. vs. 18,000 Btu./lb. for conventional jet fuel—means a 40% increase in energy content. The corresponding increase in speed is of obvious interest both from the standpoint of higher performance, and elimination of engine weight otherwise necessary to achieve comparable thrust.

Manufacture of boron fuels involves use of diborane as an intermediate in the plants of both Olin Mathieson Chemical and Callery Chemical. Diborane is subjected to heat, causing higher boron hydrides to form. These are then reacted with a hydrocarbon (probably ethylene) to produce the chemical fuels.

It is estimated that the initial two plants will have a combined capacity of 3,400 tons. This production level is relatively low, in view of the reported investment of nearly $80 million, but can be accounted for by the relatively complex process. The process involves extensive refrigeration, regeneration of alkali metals from their chlorides, and conversion of the metals to the hydrides.

Until further opportunity has been provided for evaluation of the fuels in "chemical bombers," there is no assurance that these products will be adopted widely. Some groups believe boron fuels will be primarily a supplement to conventional fuels, and used only when a burst of power is required. Other possibilities are use in mixtures or perhaps as the only fuel.

The potential for boron compounds in rockets and missiles is also being explored. Considerable effort is being devoted to development of a stable, solid, alkyl borane compound. This product would permit immediate firing of a rocket system without delays for charging a liquid fuel.

It is expected that higher alkyl borane compounds will play an important role in this application. These are under development by such groups as Stauffer-Aerojet, Callery, and American Potash.

Development of boron chemistry, accelerated by the fuel program, has also extended into new areas such as polymer chemistry. The work of Schlesinger and his associates has shown the possibility of deriving stable polymers from boron, similar in many respects to those based on silicon. Basic research is being devoted to the derivation of economically feasible boron polymers, and can be expected to culminate in commercially available products within the next several years.

Refractory Metals Force Thermal Barrier

Our best alloys fail at about 2000 F. But thinking in this atomic-space age goes way beyond this barrier. We need refractory metals—tungsten, columbium, tantalum—to match this thinking.

In the atomic and missile sciences, one common requirement for materials of construction is that they must stand up under stress at high temperatures. We have a desperate need today for better materials for use at high temperatures. Engineers have designed engines and missiles superior to those we have today, but these cannot be built until we have better heat-resistant materials.

Today's best high temperature alloys are based on nickel and cobalt. These alloys are good up to about 1700 F. By applying ceramic coatings to these alloys or by cooling them, it may be possible to increase temperatures by as much as 200 to 300 F.

However, for higher temperatures new materials must be used—new metals or new ceramic-metal combinations.

Today it appears that ceramic-metal combinations lack a number of engineering properties required to make them useful in many applications; research in this field is being accelerated.

By contrast, considerable progress is being made with refractory metals. Refractory metals of most interest currently are chromium, columbium, tantalum, molybdenum, and tungsten. These refractory metals are of interest because their melting points are considerably in excess of those metals—iron, nickel, and cobalt—which form the basis of our present high-temperature alloys.

Chromium is one of our more common metals. It is used extensively as an alloying element in steel, particularly in stainless steel, but it could become important as a refractory metal in the future.

Problems associated with chromium are brittleness and temperature limitation. Ability to produce very high purity chromium may go a long way towards overcoming these problems. At best, chromium will provide us with a material which may permit operations at 200 to 300 F. above the limits of present alloys.

Union Carbide and Metal & Thermit are the largest factors in the chromium supply picture.

Little columbium is produced as a metal today. How-

ever, it may have a very bright future. Columbium ore was in such short supply during World War II and the Korean Emergency that the large users, alloy-steel producers, had a difficult time obtaining columbium for their stainless steels and high temperature alloys.

However, as is frequently the case when an important demand for metal develops, a number of new deposits were found. Many of these columbium-bearing ores are located in Canada, and will in the future reduce our dependence upon African and Asian ore sources. While these deposits are low grade and may be expensive to process, they provide us with adequate reserves.

The high melting point of columbium has resulted in much research on less-expensive processes for producing columbium metal and the development of columbium-rich alloys. Problems associated with columbium are its relatively poor oxidation resistance and the question of diffusion.

Fansteel Metallurgical, Union Carbide, Du Pont and Kennecott Copper share the greatest part of the now-small columbium markets.

Tantalum is a metal which occurs in nature with columbium and must be separated in processing. Tantalum has important uses today in electronic capacitors for airborne and military electronic equipment, in cemented carbides, and as a corrosion-resistant material for use in process industries.

Tantalum's high temperature properties are very similar to columbium. Unfortunately, tantalum is almost twice as dense as columbium and much less available in nature. North American columbium ores contain very small percentages of tantalum. It appears we must continue to rely on African and Asian ores for our tantalum.

Unless substantial deposits are found in the Western Hemisphere, it seems unlikely that tantalum will be used as a high temperature material. Columbium instead seems a much more likely choice.

In addition to Fansteel and Union Carbide, there are at least four other important tantalum producers who will be after their share of this developing market.

Molybdenum is a rather common metal produced in quantity in the United States. Its primary use is as an alloying element in steel.

Molybdenum is a very interesting metal for high temperature applications because of its high melting point and high strength at elevated temperatures. Main drawback to molybdenum is the fact that it oxidizes readily at elevated temperatures. The oxide so formed is volatile.

Experimental aircraft jet engines containing molybdenum turbine buckets have been tested, but commercial use is not possible unless the oxidation problem is solved. Much research has been done in an attempt to overcome this oxidation problem and real progress is being made.

American Metals-Climax, Molybdenum Corp. of America and Kennecott Copper are now the most significant suppliers of molybdenum.

Tungsten is another refractory metal being considered today.

Much research is being directed towards use of tungsten because of its very high melting point, the highest of any refractory metal—almost 6100 F.

If the problem of availability can be overcome—North America is lacking in adequate tungsten ore reserves—tungsten may become an important high temperature material in spite of its high density (almost three times that of iron, cobalt, nickel, and columbium, and twice that of molybdenum).

Better processes for mining tungsten are under development. Should lower production costs become a reality, acceleration of tungsten research would be increased.

Wah Chang is the most important U. S. refiner of tungsten. But, as with most of the metals discussed, there are many other companies producing the product.

Premium Plastics Rival Metal, Glass

Plastics are appearing today which can compete in many cases with conventional materials—and beat them. Look for a plastics surge in the next decade to make past successes look like peanuts.

Over the past decade, consumption of plastic materials has grown from approximately 1.2 billion pounds to more than 4.2 billion pounds, in spite of the fact that plastic materials have generally been inferior in some respects to materials they replaced.

Plastic materials available to the public have generally been considered inferior substitutes. This somewhat odious comparison originated during the war when materials, such as rubber, were in short supply.

Looking back, it is somewhat surprising that these plastic materials—some of them highly inflammable, others extremely brittle, and all with poor properties at both elevated and depressed temperatures—have achieved growth of this nature. It is even more surprising when one thinks back of the torn rain coats, the broken toys, and the other misapplications of plastic materials.

Those plastic materials which did have fairly good properties of toughness, strength, and transparency have generally been more expensive than the materials they replaced. For example, cellulosics, acrylics and nylons have all been more expensive on a per-cubic-inch basis than glass, steel, or wood.

Now, we have commercially available materials which do have reasonable temperature properties combined with toughness and strength: Teflon, Kel-F, Fluorothene, and nylon, manufactured by Du Pont, Minnesota Mining, Union Carbide and Allied, respectively. (Spencer and Foster-Grant have recently entered the nylon picture.)

Although these materials have been available for several years, they have been severely handicapped by certain property deficiencies and a very high cost. Teflon was very hard to fabricate and cost approximately $5/lb. Kel-F and Fluorothene cost even more and were only somewhat easier to fabricate. Nylon, costing over $1/lb., had high mold shrinkage (which was often unpredictable), had poor moisture resistance, and could not be readily fabricated to close tolerances.

Despite these inadequacies, these materials have

been enthusiastically accepted by automotive, electronic-equipment, and business-machine manufacturers.

At first, these materials were so difficult to fabricate that a premium price had to be charged by the fabricator. Today, they are handled with some difficulty, but without any premium for fabrication.

In 1959, we have arrived at the beginning of an age where plastic materials will be available which will have not only the ease of fabrication generally associated with inferior plastics, but also the temperature resistance and physical properties generally associated with metals, wood, glass, and other materials.

In 1958, production was begun on three new materials: Penton, a chlorinated polyether developed by Hercules Powder; Delrin, a polyformaldehyde material developed by Du Pont; and Lexan, a polycarbonate developed by General Electric.

These three materials now give the design engineer, and the consuming public, plastics which have the properties of nonflammability, high strength, high temperature resistance, good electrical properties, and, most importantly, ability to be fabricated on standard equipment with relative ease.

1958 also saw the commercialization of polypropylene. Recently introduced in Italy by Montecatini under the guidance of Professor Giulio Natta, it is now being made in this country by Hercules.

Polypropylene is another premium material which will be low priced, will have good physical strength, and superior heat-distortion resistance.

Table II shows physical properties of these premium plastic materials. Now, at long last, industry has plastic materials which can be used in many applications where metals (like zinc, brass and aluminum), wood, glass, and other materials have been used exclusively.

And these plastic materials offer advantages, too. They can be transparent without being breakable, they are strong without being heavy, they are nonflammable, and, most importantly of all, they may be fabricated with threads, corners, grooves and turns—all to close tolerances.

They may be fabricated 5, 10, and 15 at a time, eliminating costly polishing, machining, buffing, cutting, drilling, tapping, and other operations which generally have to be performed on the metals, glass, wood, rubber, etc.

Linear Polyethylene and Polypropylene Bring New Versatility to Plastics—Table I

Property	High Density Polyethylene	Low Density Polyethylene	Isotactic Polypropylene	High Impact Polystyrene	Rigid Polyvinyl Chloride
Density	0.958–0.962	0.915–930	0.90–0.91	1.08	1.38–1.58
Melt index	0.2–5.0	0.4–30	6–20*	——	——
Heat distortion, °F. at 66 psi	165–175	107–121	——	193	140–185
Softening point, Vicat °F	260	176–224	over 284	——	——
Tensile strength, psi	2,500–5,000	1,500–2,400	4,300–5,700	3,500–8,000	——
Yield stress, psi	4,400	1,100–1,700	4,300–4,900	——	5,000–6,500
Hardness, Shore D	68	45–55	65	70	75–85
Impact strength, Izod	1.2–4.0	0.8–1.6	——	2.9	0.4–0.8
Brittleness temp., °F	−100 to −200	−90 to −165	under 14	——	——
Stiffness, 1,000 psi	150	13–42.5	114–170	320	500–560
Elongation, %	400	400–700	500–700	24	5–15
Dielectric constant	2.35	2.3	2.0–2.1	2.5–3.5	3

* Using 1,000-kg. weight—not comparable to other melt indexes in table.

With regard to the future of these materials, only experience will show how fast they may grow. Consider, however, some facts. Upwards of 240 million lb. of polystyrene, a generally brittle material, was consumed in 1957 by industry. Over 600 million lb. of polyvinyl chloride was used, despite the fact this material must generally be mixed with a plasticizer which often exudes to the surface. Phenolics, which have always been limited to black and perhaps red or green colors, with little toughness, are used in quantities exceeding 200 million lb. And 20 million lb. of methacrylates, which scratch so readily, were molded.

These materials and others accounted for approximately 900 million lb. of molding powder in 1957. This consumption is expected to increase to 1.370 billion lb. for molding alone by 1963.

When this is considered, it is exciting to speculate how fast materials which do not have these disadvantages can grow.

In predicting growth for these materials, we do not look at replacement of other plastics so much as we consider the vast quantity of nonplastic materials used by industry which have not yet faced competition from any plastic material. We refer to the 222 billion lb. of steel, the 800 million lb. of brass and bronze, the 2.6 billion lb. of aluminum, and the 13 billion lb. of glass used each year.

If only a small percentage of these materials were to be replaced by the new premium plastics—where they have a physical advantage and a price advantage—consumption figures ten years from now may well put in a shadow the startling past growth of plastic materials.

It is perhaps important to note why these materials will replace stand-by products accepted by mechanical engineers and civil engineers for generations. Plastics will replace them because of plastics' physical properties, not in spite of them.

Consider a simple brass mix-fill valve for an automatic washer. The metal has to be melted and poured into a cast, the cast has to be broken open, and the part then has to be machined down to tolerances. Total finished cost of such a part approximates $6.

Compare this, if you will, with an automatic injection machine which will in 1½ minutes completely fabricate, to accurate tolerance, as many as ten such parts. There will be no machining operations, and there will be no wastage.

Consider glass, for example, which is fragile. Now industry has, in the premium plastic, a transparent material which is hard, unbreakable, and can in one operation be formed to any tolerance required.

Another important factor is the multiplicity of units which presently go into a rather simple unit for, say, the automobile industry. It may be necessary to cast five or six different gears and mount them all on one shaft. Each must be made to exact tolerance, each must fit this shaft. There may be as many as ten different operations and items mounted in one unit package.

With the premium plastic materials, this will all be done in one operation. You can, if you wish, injection mold 5, 10, or 15 different units in one single piece.

In order to understand the future of these materials, you might look around your present surroundings. Look at the number of brass hinges and fittings in the room, the gear trains in the clock on the wall, the metal light fixtures, which add nothing but weight. Consider their being replaced with a transparent, lighter material.

Look at any relatively expensive part formed of metal or glass and consider that this could be made in a one-shot injection mold in large quantities at a cost considerably lower than it is presently being made. This, then, is the promise of the premium plastics.

Polymer Molecules Come Built to Order

New techniques in polymer modification—isotactic polymerization, block-and-graft copolymerization—create special materials, each ideally suited for perhaps just one job.

Over the years, the plastics industry has to an important degree enlarged its markets by modifying basic resin materials to suit particular needs.

In the past, this has been done on a rather broad scale with vinyl chloride resins, amino resins, polystyrenes, and others. In most cases, however, modifications have been achieved mainly through addition and mechanical mixing of extraneous ingredients.

It can be readily recognized that polyvinyl chloride resin *per se*—a rigid, intractable, and difficult-to-handle material—would never have become an item of commerce had it not been possible to mix it with plasticizers in order to achieve flexibility and ease of processing. Through the addition of these plasticizers, a rigid material has become recognized in the general public's mind as a flexible film, suitable for raincoats, shower curtains, etc.

Indeed, use of polyvinyl chloride resin, itself, has had a relatively restricted growth. Even today it has achieved a market of only about 17 million lb., largely in the form of calendered sheet for use in such items as price tags, book binders.

Thus, essentially the whole vinyl chloride industry is based on modifications through the addition of plasticizers and copolymers.

Another very good example of modification of basic polymers is the improvement in impact strength achieved in polystyrene through modification with butadiene, nitrile rubber, acrylonitrile, and other modifying ingredients. By adding these materials to pure polystyrene, it is possible to obtain importantly improved impact strength, resistance to heat, and resistance to weather.

Phenolics have been combined with rubber. Urea resins have been modified to change their ionic charge and make them suitable for addition to paper (for wet strength) and to textiles.

These are past examples of custom tailoring a polymer physically in order to achieve a product more suitable for use in presently known applications.

We are now entering a new stage of polymer modification—molecular custom tailoring, if you will—to provide materials suitable for each major application.

These changes are not merely changes in flow prop-

erties, moisture content, plasticizer and lubricity content, or particle size. They are modifications of the basic molecule. And they are not accomplished by mechanical addition of new ingredients such as plasticizers, but rather by rearrangement of the molecule prior to its polymerization or during its polymerization.

For example, polyethylene is not finding its major growth in the form in which it was originally designed. Instead, we have a variety of densities, a variety of physical properties, and a variety of end-use properties such as transparency, rigidity, ease of handling, speed of extrusion, and so forth. Without these modifications, it is quite apparent that polyethylene could never have become the important material it is today.

Table I shows comparative properties of high density polyethylene, low density polyethylene, and isotactic polypropylene. As the density of polyethylene increases, one can expect to get better stiffness, better yield strength, better low temperature properties. As melt index goes up, melt fluidity and drawability increase.

These advantages are, of course, accompanied by some disadvantages, namely decrease in tensile strength, tear strength, and weatherability.

It is typical, perhaps, that changing one property in a plastic by changing the basic molecule is going to result in some advantages and some disadvantages. As we enter this new era of changing melt indexes, molecular distributions, molecular weights and densities, we are going to have a great variety of products. We can expect that one resin will be particularly suitable for wrapping bread, that another may be particularly suitable for making pipe. It is improbable in today's advanced technology that one resin would be equally suitable for both.

Modifications in the resins today are not, as was previously the case, for the advantage or requirement of the fabricator. Rather, they are to provide a superior end product for a particular application.

It is important today to recognize that the whole area of polyolefins has, as in the beginning of most other plastic materials, been restricted primarily to modifications of the basic ethylene or propylene unit. Experimental work in 1958 indicated that, parallel to past experience, there will be a widening opportunity for copolymerization either by graft or block methods.

Thus, it is now possible to predict copolymers of acrylics with polyethylene, vinyls with polypropylene, and silicones with polyethylene.

With the recent introduction and commercialization of isotactic polymerization, we have the possibilities of various types of styrene molecules being grafted, or copolymerized with more prosaic molecules, to give a great variety of properties, each particularly suited for one or perhaps two applications.

Styrene can be grafted to polyethylene, either in the molecular chain or cross linked to the main chain. Acrylics can be copolymerized with the vinyl acetates. High energy irradiation promises to make possible a plastic with the surface properties of an acrylic and perhaps the internal toughness of a vinyl.

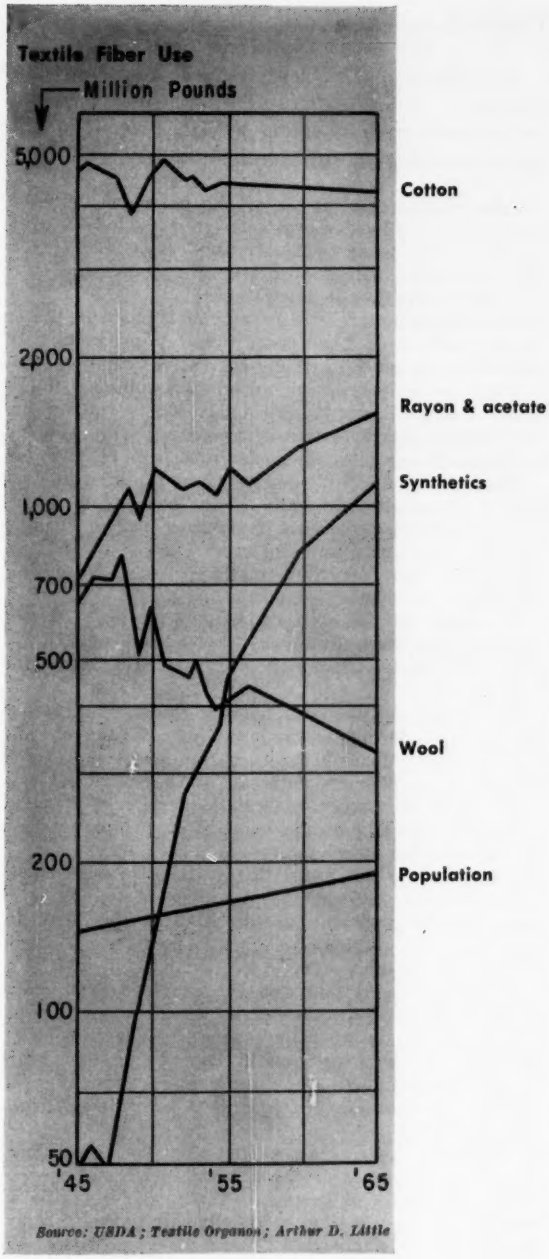
As we look into the future we doubt that the trend will be towards great volumes of basic materials such as polyethylene, polystyrene, and polyvinyl chloride. Instead, it appears that there will be relatively small quantities of special copolymers and terpolymers, each ideally suited for perhaps one need. As copolymerization and modification of the basic polyvinyl chloride resin led it to a growth of 900 million lb., we also expect that modifications and copolymerizations with polyethylenes and polypropylenes will allow growth of a comparable magnitude.

These are not materials of nature that must conform to a rigid molecular structure. They are man-made molecules that can be changed to suit the environment and application of their use.

Premium Plastics: Properties to Challenge Wood, Metal and Glass—Table II

	Impact Notched Izod	Heat Distortion °F., 66 Psi.	Water Absorption Wt. %, 24 Hr.	Mold Shrinkage In./In.	Dielectric Constant 60 Cps.	Price Range $/Lb.*
Fluorinated						
Teflon	2.5–4.0	250	0.00	——	2.0	5.00
Kel-F; Fluorethene	3.6	240	0.00	0.005–0.01	2.7	8.00
Extreme-Performance						
Penton	0.4	300	0.01	0.004–0.006	3.0	3.00–1.50
Delrin	1.4–2.3	338	0.40	0.02	——	1.00–0.85
Lexan	12–16	290	0.30	0.005–0.007	3.17	2.50–1.00
Nylon	0.9–2.0	360	1.50	0.020	3.9	1.18–0.90
Polyolefins						
Linear polyethylene	1.2–1.4	170	<0.02	0.020–0.050	2.35	0.43–0.35
Isotactic polypropylene	1.2–1.4	212+	<0.02	0.020–0.050	2.0	0.49–0.35

* Lower figure denotes possible future price.



It is certain that the number of products available to the plastics fabricator ten years from now will be bewildering. It is also probable that he will not know all the chemistry or molecular configurations of these materials.

But he will have a choice of properties, designed to suit his machinery for the applications which he has in mind. This, then, will be the major growth area of polymer materials over the next decade.

Synthetic Fibers Multiply and Compete

New chemical-fiber species, new members of new species, new blends of new members—all slugging it out with wool, cotton, rayon, and each other for fabulous textile markets.

Evolution of synthetic fiber materials has been slow, and has followed the path of duplicating nature's products. It was a bright day when the Du Pont organization brought out nylon, the first synthetic polymeric material suitable for textile use. A great deal of money, some $27 million, was expended to produce the first pound of nylon.

Nylon almost immediately replaced silk in ladies' stockings, and has since displaced much rayon, as well as more silk. But it did so only at a very great cost in educating the public that a synthetic fiber can have material advantages over a natural fiber.

In 1946, the acrylic fibers were introduced to the public. They had no one single application, such as stockings, where they had a proven advantage over the material they sought to replace, but they did find some advantage in blankets and sweaters. It then became apparent that acrylics could be blended with wool to provide a final material which had some of the properties of wool and some of the properties of acrylic fibers.

Slightly modified acrylics were brought into the market by Du Pont (Orlon) and Chemstrand (Acrilan).

The next star on the textile horizon was the polyester Dacron, developed by Du Pont. Dacron was originally thought to be the first material which could be used alone in apparel applications. In response, however, to such problems as pilling and accumulation of static charge, it was shortly found that mixing the polyester with wool provided a better use.

In 1958, we saw the announcement of several additional synthetic fiber materials and important expansions in capacity for others. Dow and American Cyanamid announced acrylonitrile fibers, Zefran and Creslan. Tennessee Eastman announced a new synthetic acrylic fiber material, Verel. And in the closing months of last year, Air Reduction announced it is planning to produce vinylon, a polyvinyl alcohol fiber now manufactured in Japan.

We also expect that other companies will make polyesters similar to Dacron; indeed, such facilities are planned by Tennessee Eastman, Beaunit Mills, and Celanese-ICI.

Thus, in the year 1959, we are confronted not with one acrylic fiber, one polyester, one nylon, but with several new materials, none of which has found a particular niche in the market, and all of which will be competing for a share of the market now dominated by cotton, rayon and wool.

The graph shows past and projected consumption of cotton, wool and the synthetic fibers. It is apparent from this graph that wool has already suffered a serious inroad from the synthetic fibers, and will continue to decline. Cotton and rayon markets are now under attack by synthetic fibers.

Cotton and rayon have two very important advan-

tages: They are inexpensive; and they are recognized by the consumer for what they can and what they cannot do. It will take a long program to educate the buyer to understand the advantages of a polyvinyl alcohol fiber, a vinyl cyanide fiber, and others.

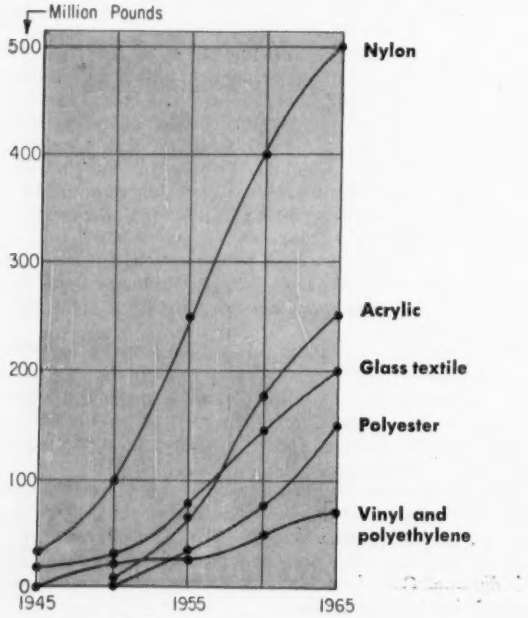
It will take a long while before textile companies can learn to properly mix these materials so as to come up with an overall product the consumer can recognize as being superior to cotton or rayon. Yet this is the promise we see in 1959 and later years.

Two major factors exist in 1959 for the first time which will effect a change in textile usage. First, there is substantial overcapacity for nylon, enough to permit nylon to replace virtually all the rayon now used in tires. To fight this threat, the rayon industry is promoting Tyrex, an improved rayon tire cord.

Secondly, there is substantial overcapacity in acrylics since, in addition to new producers mentioned, both Du Pont and Chemstrand have completed substantial expansions. These expansions have taken place despite the fact that only one fiber, acetate rayon, showed any growth last year.

Therefore we foresee a period of intense competition among the various fibers and the many producers. This competition may well result in lowered prices and, consequently, a time in the not-too-distant future when consumption of synthetic polymers may approach that of rayon. Certainly by that time there will be many new synthetic fibers competing with the ones which hold the spotlight today.

Synthetic Fiber Production



Source: Textile Organon; Arthur D. Little

Petrochemicals Look for New Work

Hydrocarbon acetylene moves into merchant channels. Isoprene's future hangs on success of polydiolefin rubbers under study. Propylene gets upgraded to glycerin, acrolein and polymers.

Like many other areas of the chemical industry, petrochemicals are emerging from a period of overglamorization to one of more application of effort to find means for utilization of existing plants and more realistic evaluation of future needs.

During the past few years, emphasis has been placed upon creation of basic facilities for production of hydrocarbons and primary derivatives that require further processing for such markets as plastics, fibers, rubber, and detergents. Probably most striking has been the dramatic increase in capacity for ethylene, particularly for merchant sale instead of captive use.

Growth in ethylene capacity from 3 billion lb. to 5 billion lb. in the last three years has foreshadowed a rapid expected increase for major outlets such as ethylene oxide and polyethylene. The polyolefin market, alone, has probably justified some $70-million worth of new ethylene facilities.

Principal ethylene producers are Union Carbide, Gulf Oil, and Esso Standard Oil. Newer producers include Petroleum Chemicals, Phillips Petroleum, and Humble Oil.

Most new ethylene is coming from refinery-gas processing, augmented by cracking of ethane from natural gas. Major petroleum companies will hence maintain their prime interest in the field, but will increasingly be concerned with conversion of ethylene to plastics and chemicals, in addition to manufacture of ethylene for merchant sale.

Since ethane is potentially available in substantial quantity from natural gas stripping at a number of locations, geographical considerations might favor its conversion to ethylene at selected points near major markets for derivatives.

Only significant new use for ethylene is in alkyl borane compounds discussed above, although this requirement is now filled by ethanol dehydration. Ultimate use of ethylene for alkylation to produce high-octane blending stocks may change economics of chemical conversion considerably—but this is some distance off.

The basic petrochemical industry has been hard pressed to maintain profitability at satisfactory levels, what with reduced prices for many of the building blocks like benzene, styrene, phenol, phthalic anhydride, and vinyl chloride. Increased competition has led to extension of the trend towards vertical integration on the part of principal manufacturers. Wider availability of process know-how for making derivatives has also provided means for exploitation of upgraded products by many basic manufacturers.

Some of the most interesting recent developments in petrochemical upgrading have included: Union Carbide's technique for polymerization of ethylene oxide to produce (Polyox) resins that may have interesting markets where water solubility is a valuable feature; Amoco Chemicals' adoption of a new process for oxi-

dation of xylene isomers to yield a mixture of phthalic acids (rather than traditional separation of xylene isomers with separate oxidation to the corresponding acids); and Shell Chemical's installation of facilities for production of glycerin and acrolein, via oxidation of propylene.

Isoprene now gives promise of becoming a petrochemical of major commercial stature. It will provide raw material necessary for commercial-scale manufacture of rubber polymers having properties resembling those of natural rubber.

Traditional recovery of isoprene as a byproduct of gas-oil cracking will not be sufficient to supply the contemplated major market for synthetic natural rubber, making it necessary to perfect processes based either upon dehydrogenation of isopentane or synthesis from shorter-chain hydrocarbons.

B. F. Goodrich, Firestone Tire & Rubber, and Goodyear Tire & Rubber are all working intensively on perfection of techniques for isoprene polymerization to yield an ordered chain structure. Phillips Petroleum, pursuing the route based on butadiene polymerization, has achieved substantial success in producing rubbers useful in heavy truck tires.

There is good likelihood that two or three demonstration facilities for polydiolefin rubbers, having a combined capacity of 50,000-100,000 tons, will be built in the next 3-4 years, although there is currently no assurance that the product will be competitive, costwise, with natural rubber.

One of the most interesting prospects for future development in the petrochemical industry is the emergence of hydrocarbon acetylene as a building block for organic chemicals.

Of particular interest is the development of new merchant-acetylene centers. Calcium carbide acetylene has traditionally been an important merchant product, moving by pipeline at major producing points such as Niagara Falls, Ashtabula, O., and Calvert City, Ky. Essentially all capacity for petrochemical acetylene, though, has been directed towards captive consumption.

The three major plants of Union Carbide, American Cyanamid, and Monsanto Chemical are all devoted to conversion of acetylene to derivatives such as acrylonitrile, vinyl acetate, and vinyl chloride.

Rohm & Haas has recently completed facilities which will be directed primarily to conversion of acetylene to the acrylate esters. And Dow Chemical is now constructing facilities which will make acetylene for use in a number of derivatives, including acrylonitrile.

Phillips has indicated interest in manufacture of acetylene for merchant sale. The firm will probably obtain acetylene as a byproduct of hydrocarbon cracking to produce ethylene.

Such projects place relatively-low-cost acetylene at the disposal of the chemical industry in the Southwest where carbide-derived acetylene has been relatively expensive.

Probably one of the first acetylene targets will be vinyl chloride manufacture, where use of the combined ethylene-acetylene process permits balancing of hydrogen chloride availability and use. Other installations for more complex derivatives—like butynediol, propargyl alcohol, and cyclooctatetrene—may then follow.

Oral Pharmaceuticals Aim at Mass Market

Oral drugs make the news: antidiabetics (sulfonylureas), diuretics (chlorothiazides), even polio vaccine. Psychic stimulants stir the overly tranquil. All-out assault on cancer grinds ahead.

In this industry annual government and private research expenditures amount to an estimated $330 million. Little wonder, then, that new drugs and medical breakthroughs are now considered routine. Nevertheless, the year 1958 was largely a year of consolidation and improvement of existing products rather than one displaying major advances of the stature of the Salk vaccine or the tranquilizers.

However, a number of very important advances in research were made, particularly in the fields of cancer control. Psychic energizers were actively promoted. Many new combination products—those composed of two or three vari-functioning ingredients—were offered to the ethical trade.

Introduction of the so-called oral antidiabetic pharmaceuticals made substantial inroads on insulin markets; further penetration in 1959 is anticipated because new products are being readied for the market.

Combined government, institutional, and industrial research in the field of cancer is of substantial magnitude. In 1957, the government alone spent $9-$10 million to screen existing compounds.

The reward for the successful solution to the cancer puzzle is largely in terms of the relief of human suffering. Although one person in four will have a malignancy sometime during his lifetime, it is doubtful that a single compound will be equally effective for the hundreds of types of human cancer. It is not anticipated that the overall market for any single compound will be large.

Researchers are now able to cure or control many malignant tumors produced or occurring in mice, but the same compounds fail to produce comparable results in humans. The link between the mouse and man depends on differences in the tumors themselves, and on

dissimilar metabolic functions. Identifying the missing link may provide the answer to cancer control, now so diligently sought.

Various approaches to cancer control are being taken, but antibiotics and steroids are the two most promising classes of compounds so far.

As research for safer and more effective tranquilizers continues, drugs with just the opposite effect—"phychic stimulants"—have recently made news. Psychic stimulants to overcome depression and elevate the mood are recognized as valuable medical tools and, although not new in medicine, are receiving renewed attention by major pharmaceutical firms that do not now have products of this type. A psychic stimulant is frequently recommended as a central stimulant to assist a patient in dieting.

Hoffman-La Roche, Riker Laboratories and Wallace Laboratories are presently marketing products in this growing field.

Diuretics are compounds that control swelling caused by accumulation of body fluids (edema), an occurrence often associated with heart disease and pregnancy. A major breakthrough last year was the introduction of chlorothiazide (Merck's Diuril). This product can be taken orally, and its effectiveness is maintained after prolonged use. It also is very useful in treatment of high blood pressure.

New products similar to Diuril are now appearing with superior effects claimed. Ciba's Esidrex (dihydrochlorothiazide) and Merck's HydroDiuril (hydrochlorothiazide) are two of these.

One very bright spot in the pharmaceutical industry is the success of Upjohn's Orinase in controlling diabetes. Orinase, a compound that can be administered orally instead of by hypodermic injection as with insulin, already has sales at an annual rate of about $10 million/yr. Present annual insulin market is about $21 million.

Pfizer's oral antidiabetic, Diabanese, just released, should show a substantial growth rate during the next few months. It is reported to be a longer-acting drug than Orinase.

All compounds presently on the market are primarily for the control of diabetes in individuals over thirty, who inherently have the ability to produce insulin in their systems. These oral "insulins" are not effective in controlling diabetes in young people incapable of producing their own insulin.

U. S. Vitamin Corp. claims it has developed a product, now under clinical test, that will be effective for both young and old. If so, the ordeal of the hypodermic needle may soon be over for the diabetic.

Although not as spectacular as Salk vaccine for control of polio, Asiatic-flu vaccines produced by the U. S. pharmaceutical industry were brought to market in record time—an indication of what the industry can do when it throws its full efforts behind a project.

Flu-vaccine markets may fluctuate from year to year depending upon the extent of outbreaks, yet world markets are of great potential interest to United States companies. As far as is known, Poland is the only country behind the Iron Curtain that has had a significant supply of flu vaccine, and this was all from American sources.

Despite the fact that millions have received Salk vaccine, millions more have not. One restriction to greater distribution of the drug: it must be administered hypodermically by a skilled technician or doctor.

A major breakthrough in the form of a vaccine to be taken orally has been announced by Lederle Laboratories, Division of American Cyanamid. Unlike Salk vaccine produced from killed virus, Lederle's new product is an attenuated live-virus vaccine.

These live, but weakened, viruses are incapable of causing paralytic polio, but are able to cause the body to manufacture polio antibodies. Oral polio vaccines should do much to cultivate more widespread use both here and abroad.

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JOHN WALSH, *a Senior Staff Associate at ADL, has worked on technical and economic aspects of plastics and resins ever since he received a B.S. in organic chemistry from Middlebury College in* 1942. *Walsh was associated with American Cyanamid from* 1942 *to* 1951, *when he joined the staff of Arthur D. Little.*

DUANE M. FEELEY, *a project leader at ADL for four years, has worked on market research, product diversification and company acquisition and mergers. He worked seven years for Monsanto Chemical in sales and sales development of industrial chemicals. Feeley received a B.A. in organic chemistry from Rice Institute in* 1946.

Liquid Fertilizers Pack More Plant Food

Fertilizer makers build better liquid products, pack more into them—a faster, surer way to deliver food to the plant and give better margins to producer, distributor and farmer.

The long-term trend towards higher-analysis materials—providing savihgs in handling, bagging, and freight—continues to be one of the most active trends in the fertilizer industry. Average content of N, P_2O_5 and K_2O in fertilizers is now running at a level of about 30%.

Development by TVA of a process for superphosphoric acid analyzing 76% P_2O_5, vs. conventional 54% P_2O_5, provides further stimulus in the direction of higher-analysis materials.

This product should permit manufacture of higher-analysis liquid fertilizers which are more competitive on an analysis basis with dry products like ammonium phosphate. Reducing the burden of transporting additional weight, in the form of water, when using the liquid mixed fertilizers should enable these products to gain wider acceptance by producers, distributors and farmers alike.

The trend towards more liquid products continues to be one of the most important facets of fertilizer growth. Complete liquid fertilizers containing nitrogen, phosphate, and potash continue to grow in the Middle West, particularly in Illinois.

In addition, several sections of the country have been turning rapidly towards direct application of nonpressure nitrogen solutions. Although both pressure and nonpressure nitrogen solutions compete with direct application of anhydrous ammonia to a certain extent, the principal area that solutions are aiming at is the solid-ammonium-nitrate market.

Urea-containing solutions, averaging about 32% nitrogen, have shown particular growth, and are expected to make further inroads on other nitrogen material applied directly to the soil.

While the overall outlook for use of chemicals in agriculture is improving because of higher farm prosperity, suppliers of plant food continue to be plagued by price competition and oversupply. The year just ended probably saw more new facilities for primary plant-food materials (particularly nitrogen and potash) brought into production than any other peacetime year in U. S. history.

These plants represent the culmination of a period of earlier planning and plant construction stimulated by the rapid postwar increase in plant-food use. The result has been the creation of a higher proportion of overcapacity for primary plant-food materials than has prevailed for many years. Typical operating rate, for facilities producing primary nitrogen, phosphate, and potash materials, is less than 70% of rated capacity.

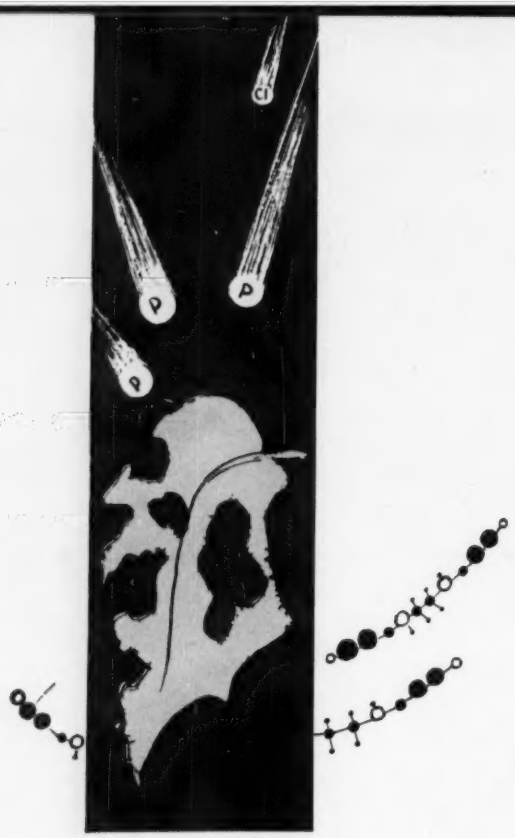
Production difficulties experienced in many new ammonia plants have helped to offset the burden of excess capacity, although most of these problems have recently been resolved.

The pricing situation for nitrogen products has been confused by a number of special arrangements in selected areas. The prospective reduction in synthetic ammonia prices to \$63-66/ton on the West Coast reflects intense competition among suppliers for markets in that area.

It is interesting to note that the the proportion of overcapacity in the western area is, in fact, substantially greater than the proportion for the rest of the country.

Potash has also declined—from 36¢/unit K_2O to 31¢/unit—although the impact of Canadian potash production remains to be felt. Development of deposits in Saskatchewan is actively under way, although some lease-holders of these deposits are awaiting improvement in the potash market outlook before proceeding with their plans.

The fertilizer season ending last July provided disappointment for many manufacturers because the expected increase in demand did not materialize. While additional soil moisture undoubtedly contributed to demand growth in the Southwest, the excess of moisture in many parts of the country acted adversely on fertilizer consumption. Thus, growth in some areas was cancelled by slack demand in others, with no significant change in overall consumption of plant food material.



Pesticides Deliver Selective Kill

Shift to phosphate insecticides points up perplexing demands on any pesticide: It must be precisely lethal, overcome adaptive resistance, yet work well within safety regulations.

The pesticide portion of the agricultural chemicals field has shown a significant upturn in the past year, and gives promise of developing the stature long predicted for it.

Insecticides are characterized by dependence on weather—which affects the level of infestation—and continued displacement by new materials and techniques. About 70 insecticides are now marketed commercially. Biological control of insects, involving use of specific viruses or bacilli and use of lures, is receiving active attention because of its highly selective, positive action.

Although herbicides, fungicides, and nematocides are regarded as the most promising products in the pesticide field, specialty insecticides are still under investigation by many companies. Emergence of resistant strains of insects has necessitated constant shifting among products, with emphasis on materials having higher potency.

One instance is a continued shift from the chlorine family to the phosphate family. Phosphates, in general, have much higher toxicity levels and can be used in significantly smaller quantities than most of the traditional chlorine-based insecticides. Because they go further, phosphates can thereby offset their cost disadvantage.

Phosphates tend to be nonresidual, of increasing importance in view of governmental regulation of residue tolerances. Stauffer Chemical's Trithion (*O, O*-diethyl-S-*p*-chlorophenyl thiomethyl phosphoro dithioate) is an example of the newer organophosphate materials in the insecticide field.

The possibility of wider use of systemic materials continues to provide one of the most interesting areas for research work in this field. One example is Thimet, used primarily on cotton and vegetables for sucking insects. Others are Demeton (Systox), now widely used, and Bayer's Co-ral, used as a systemic insecticide for cattle.

The work-horse of the insecticide field, DDT, is relatively stabilized in the domestic market, but should grow substantially in exports to countries using it for malaria control. The U. N. and the ICA are expected to continue to support shipments to other countries beyond their ability to produce economically.

Two of the interesting new insecticides: Union Carbide's Sevin (1-naphthyl N-methyl carbamate), which is like DDT in having a wide potential in addition to being safe for humans; and Food Machinery's Thiodan (hexachlorohexahydro methano benzodioxathiepin oxide), an effective tobacco insecticide. Guthion, Chemagro's phosphate insecticide, shows considerable promise for use on cotton.

Some 40 herbicides are now marketed commercially, most based on 2,4-D or 2,4,5-T. This area shows a large potential for growth since losses due to weeds are still twice those due to insects. The most important current trend in the field is toward some specific herbicides.

Two examples: the 2,4-D butyric acid derivatives, particularly the amines, salts and esters, which are used for post-emergence treatment of corn and peanuts; and the substituted triazines, such as Geigy's Simazin, which is 2-chloro-4, 6 bis (ethyl amino)-S-triazine. This product shows spectacular selectivity when used for corn treatment.

Another product of interest is Stauffer Chemical's Eptam (ethyl di-*n*-propyl thiol carbamate), which is an all-purpose herbicide useful for both grasses and broad-leaf weeds.

Fungicides and soil fumigants are growing rapidly, as some of the new and more effective products become available. Glyodin and captan, both dithiocarbamates, are typical among the versatile and safe fungicides. D-D mixture and methyl bromide continue to see wide use in soil fumigants. Vapam (sodium methyl dithiocarbamate) is also of interest in the latter market.

New charts provide . . .

Quick Way to Radiant Heat Transfer

In your next design eliminate tedious calculations by using these simple charts for getting a radiant heat transfer coefficient.

AARON FEDER, Marquardt Aircraft Co., 16555 Saticoy St., Van Nuys, Calif.

Proper design of furnaces, oil heaters, boilers, ramjets, afterburners must take into account heat exchange between combustion gases and an enclosing duct.

This is no easy problem, particularly in calculating thermal radiant heat exchange. It is essential to account for nonluminous gas radiation—combustion products such as CO_2 and H_2O absorb and emit significant thermal radiation. The magnitude of this radiation can be a large fraction of total heat transfer.

Of course, there are methods for calculating this radiation.[1,2,3] But they are tedious and time-consuming.

We have developed a simple and complete graphical solution which greatly decreases calculation time while retaining accuracy. The technique calls for inserting variables into three "go-around" charts which yields a radiant heat transfer coefficient.*

Some words of caution are necessary, however, before using these charts. They are based on hydrocarbon-air combustion gases, specifically nonluminous gases (CO_2 and H_2O) resulting from the combustion with air of a fuel having a 0.182 hydrogen/carbon weight ratio. This is a typical value for kerosene and jet fuels.

The charts presented are accurate to within 6%. And there are methods available for extending the charts to include rich mixtures, other hydrocarbons and non-hydrocarbon fuels.

How To Use Charts

In using the curves, the following variables must be known:

- Fuel-air ratio.
- Duct surface temperature, F.
- Gas temperature, F.
- Gas to duct temperature ratio expressed in Rankine degrees.
- Static pressure in psia.
- Beam length for rays of radiation, ft.
- Emissivity of duct surface.

Having the above variables, the radiant transfer coefficient can be found. Proceed as follows for Chart 1:

1. Go vertically from a value of fPL to a value of T_g in Ia.
2. Move horizontally to the curve for P.
3. Proceed vertically to value of T_g in Ic.
4. Move horizontally to a value of T_g in Id.
5. Read directly downward for the value of $\epsilon_g\ (T_g/100)^4$.

Now go into Chart 2:

1. From a value of $fPL/(T_g/T_s)$ move horizontally to a value of T_s in IIa.
2. Proceed vertically to T_g/T_s value in IIb.
3. Move horizontally to a correct pressure P in IIc.
4. Then vertically to a T_s value in IId.
5. Move to the value of T_s and fPL in IIe.
6. Read $a_g\ (T_g/100)^4$.

After subtracting the value of Chart 2 from the value from Chart 1, go into Chart 3:

1. Read down to the difference $(T_g\text{-}T_s)$ in IIIa.
2. Move horizontally to ϵ_s in IIIb.
3. Read up from this point to get value for h_{rg}.

Work an Example

Let's take a typical example and see what answers we get. Assume a fuel air ratio of 0.067; surface temperature of 2,460 R., gas temperature of 4,220 R.; chamber pressure is 40 psia.; radiation path length is 2.1 ft.; duct emissivity 0.60.

Thus $T_g/T_s = 1.72$, $fPL = 5.63$,

$$\frac{fPL}{T_g/T_s} = 3.27, \text{ and } T_g - T_s = 1{,}760 \text{ F.}$$

From Chart 1: $\epsilon_g\ (T_g/100)^4 = 3.75 \times 10^5$
From Chart 2: $a_g\ (T_s/100)^4 = 9.4 \times 10^4$
From Chart 3, where $\epsilon_s = 0.6$, $h_{rg} = 22.0$

Extending Graphical Solution

Rich Mixtures—It is recommended that when the charts are applied to rich mixtures, f should be given the value of 0.067 (stoichiometric). But T_g (gas temperature) should correspond to the actual fuel-gas ratio considered.

Different Hydrocarbons — A fairly accurate correction for variation in the hydrogen-carbon ratio (weight) may be made by reading the curves at a fictitious fuel-air ratio, f' given by:

$$f' = f_{\text{actual}}\left[\left(\frac{H/C}{0.182} + y\right)\Big/(1+y)\right]$$

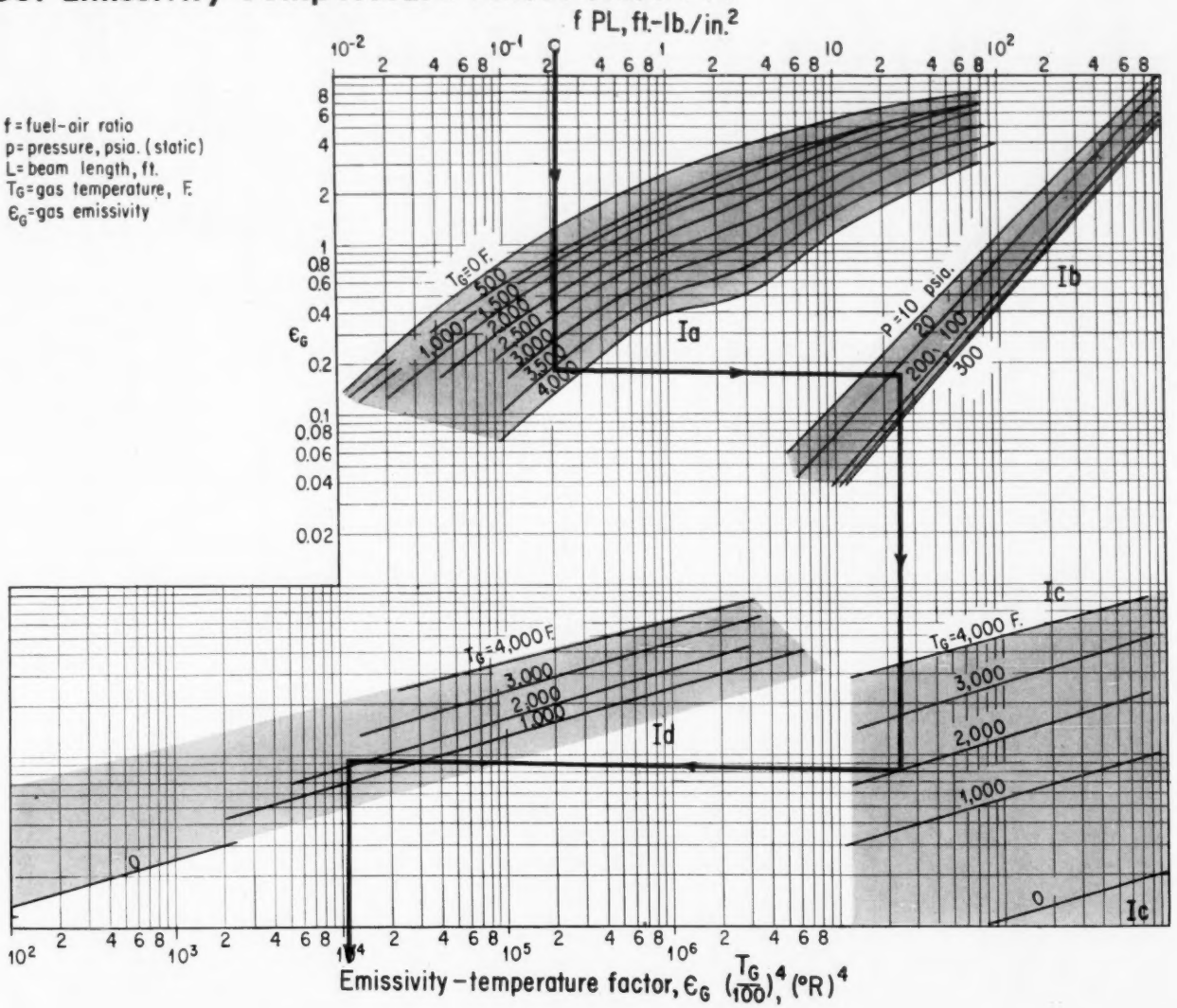
Here $y = k_2\ (fPL)^{k_1}$. For fPL from 0.1 to 15 use a k_1 of -0.242;

Nomenclature

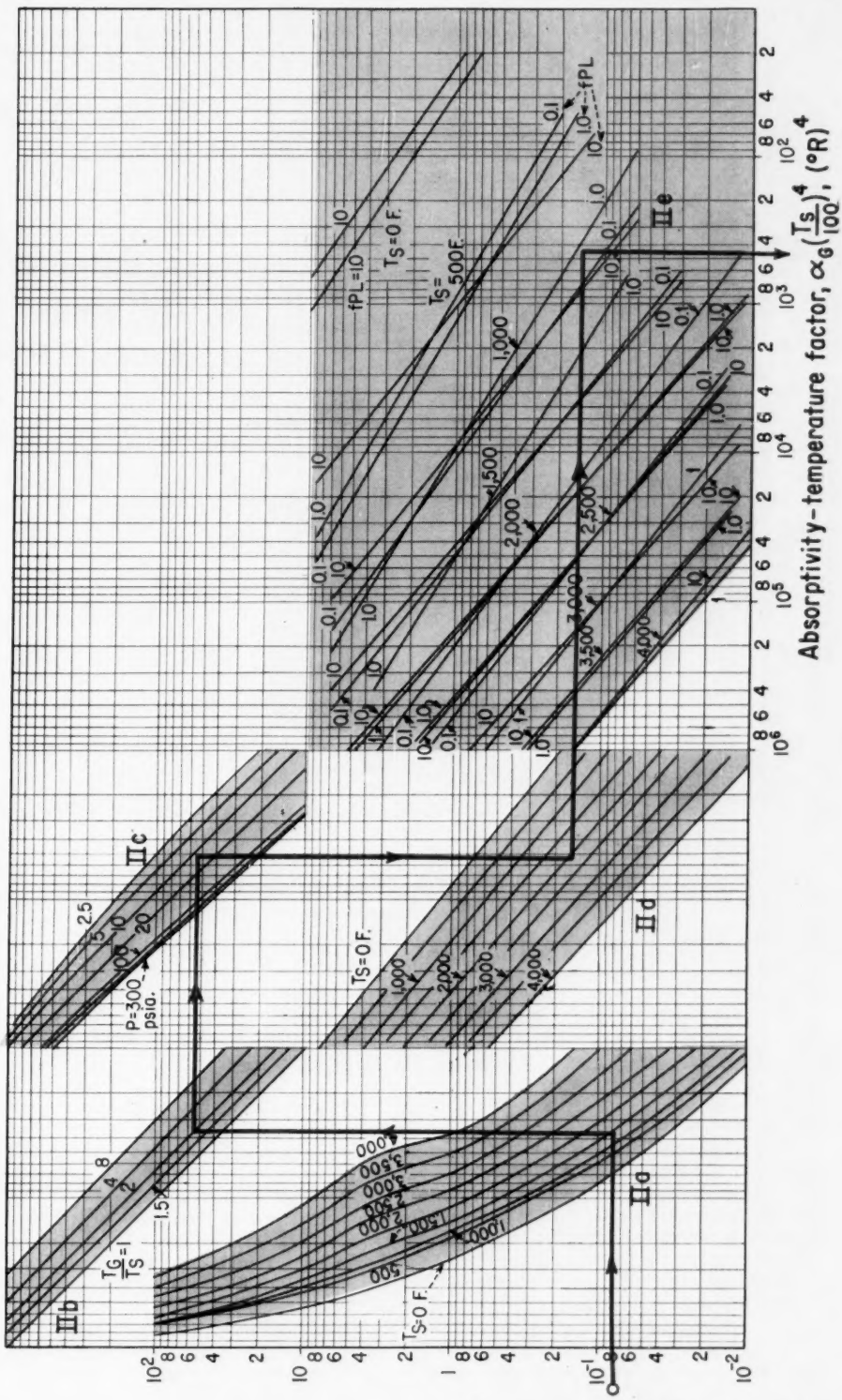
f	Fuel/air ratio.
h_{rg}	Radiant heat transfer coefficient from gas to wall, Btu./hr./sq. ft./F.
L	Path length for rays of radiation, ft. = 0.9 D where D is diameter of a cylindrical combustion duct (Also see Ref. 1, p. 88).
P	Chamber static pressure, psia.
T_g	Gas temperature, F.
T_s	Chamber surface temperature, F.
T_g/T_s	Temperature ratio where T_g and T_s are in deg. Rankine.
a_g	Gas absorptivity (CO_2 and H_2O).
ϵ_g	Gas emissivity (CO_2 and H_2O).
ϵ_s	Chamber surface emissivity.

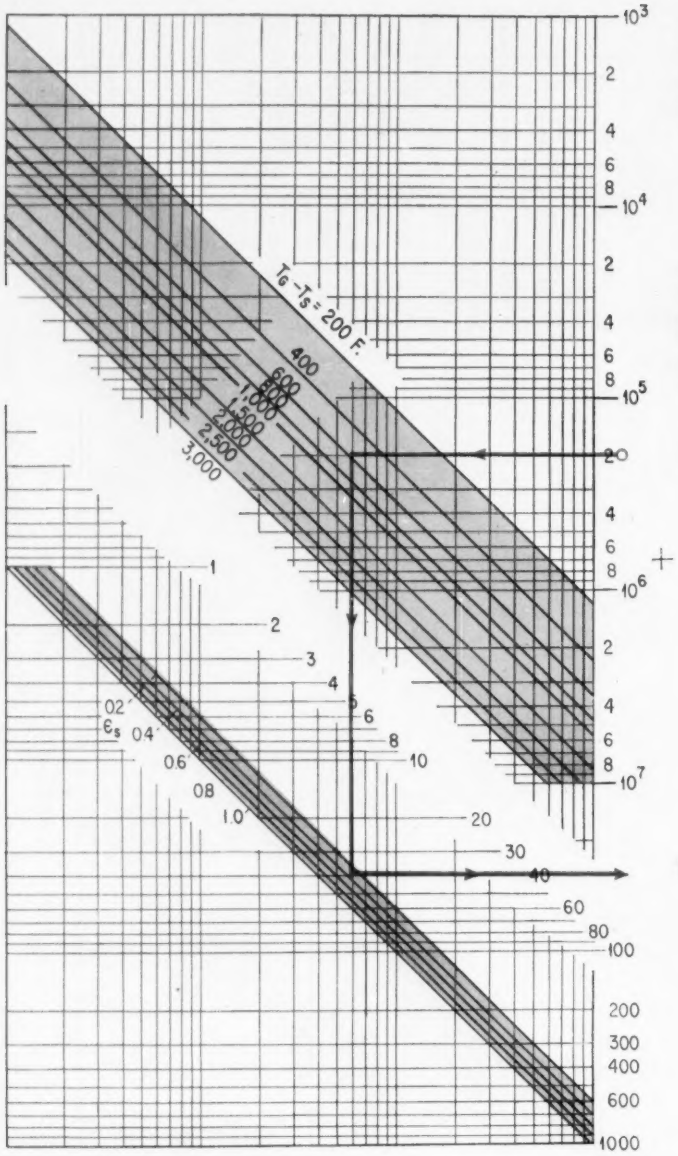
* A complete description of the theory and assumptions used in constructing the charts may be obtained from the author on request.

1. First Get Emissivity-Temperature Factor Here . . .



2. Then Read Off the Absorptivity-Temperature Factor . . .





T_G = gas temperature, F.
T_S = surface temperature, F.
ϵ_G = gas emissivity
α_G = gas absorptivity
ϵ_S = surface emissivity
h_{rg} = transfer coefficient, Btu./hr.-ft.^{2} F.

3. Enter With Difference Between Two Factors . . .

$$\epsilon_G \left(\frac{T_G}{100}\right)^4 - \alpha_G \left(\frac{T_S}{100}\right)^4$$

. . . Read Radiant Heat Transfer Coefficient From Chart

Radiant transfer coefficient, h_{rg}

k_2 of 1.429 for 2,000-4,000 F., 0.960 at 1,000 F., 0.530 at 0 F. For fPL 15 to 80 use k_1 of +0.227; k_2 of 0.385 at 2,000-4,000 F., 0.273 at 1,000 F., 0.208 at 0 F. Use the calculated f' value when going into the three charts.

Non-Hydrocarbon Fuels—For a rough approximation, the charts presented here can be used. They should at least reflect relative severity since the quantities, gas temperature, gas concentration (gas pressure) and path length appear to be controlling for all luminous and nonluminous gas radiation.

Other Path Lengths—For a gas enclosure which does not approximate the shapes tabulated in Ref. 1, use the following formula:[2]

$$L = 0.9\,(4V/A)$$

where V = enclosure volume, cu. ft.
A = enclosure surface area, sq. ft.

The charts as presented here are plotted for the following ranges: fPL—0.1 to 80 ft.-lb./sq. in.; P—2.5 to 300 psia; T_s and T_o—0 to 4,000 F.

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- What are the aims of corrosion testing?
- What physical measurements help evaluate corrosion?
- What are the requirements of a good corrosion test?
- How do we use accelerated corrosion tests?

Correlate Corrosion Testing Methods

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The ultimate test of corrosion resistance of any material is its endurance in actual service. To predict this endurance as closely as possible, we use various corrosion tests. Unfortunately, even the best tests are neither universally applicable nor totally reliable, since they involve many environmental factors and variable material properties.

We know that seemingly minor differences in manufacturing and fabrication procedures can affect markedly the corrosion resistance of most materials. Hence, assurance of truly representative samples is a major problem in all corrosion testing. Equivalence of exposure conditions is always difficult to achieve, especially for accelerated tests.

However, through experience we learn which tests are best for a given need and what safety factors must be applied to the test results. Recent developments in statistical analysis of data provide useful techniques for dealing with problems of reproducibility inherent to corrosion testing.

To understand better the usefulness and the limitations of the many corrosion tests in common use, we classify them according to their principal objectives. In the table above, we list these objectives.

Corrosion Test Objectives

- Study the corrosion mechanism and the factors that influence it.
- Select the best material or protective coating to withstand a particular corrosive environment.
- Determine the environments which a given material withstands.
- Develop materials for particular uses.
- Study the effectiveness of various protective measures.
- Control product uniformity in the manufacture of corrosion-resistant materials.

Corrosion tests may be further described as laboratory tests, field tests or service tests depending upon the manner in which they are carried out. Laboratory tests afford the closest control of significant variables but do not always aim at exact duplication of service conditions. Correlation of laboratory results with performance of materials in actual use is essential to proper validation of test procedures. In field tests, materials are exposed for long periods of time to pertinent natural environments over which some degree of control may be exercised.

In service tests, materials are exposed to actual service conditions. These tests are done by inserting coupons (specimens) into operating plant equipment or by constructing a small pilot plant of test materials.

For many years a concerted but fruitless effort was devoted to the development of a universal laboratory accelerated corrosion test which could accomplish the general objectives given in the table. Among these accelerated tests were the salt-spray test, several acid immersion tests and various simulated atmosphere tests.

These attempts failed to yield the desired all-purpose test for two significant reasons. First, in intensifying corrosion conditions to produce severe attack over a short test period, the artificial environments used do not even approximate conditions encountered in actual service. Second, different materials behave in such widely varying ways that no single test environment can apply equally well to all materials.

*To meet your author see *Chem. Eng.* Nov. 17, 1958, p. 154.

Common Methods for Evaluating Corrosion Effects, Table I

	Application	Advantages	Limitations
Visual observation	Detect occurance of attack and identify its general nature.	Simple Confirms other data	Subject to human error Qualitative only
Weight change	Determine extent and rate of uniform corrosion.	Simple Quantitative Direct	Errors in sample cleaning Not applicable to special types of attack Multiple specimens required
Microscopic	Identify type of attack Measure depth of attack and pitting Determine relative attack on alloy components Follow changes in crystal structure	Excellent supplementary method	Not always quantitative
Physical property change	Evaluate deterioration of material via tensile strength, ductility, impact, resistance, hardness, etc.	Direct measurement of change in structural properties	Measures total effect; does not distinguish effects of several types of attack
Electrical resistance change	Follow property and composition changes Evaluate environment corrosivity	Non-destructive Adaptable to continuous measurement.	Indirect, requires calibration; Does not distinguish between types of attack Subject to surface-to-volume errors
Hydrogen evolution	Laboratory tests where hydrogen evolution occurs in corrosion mechanism	Adaptable to rate measurements	Does not determine distribution of attack
Oxygen absorption	Laboratory tests where oxygen absorption occurs in corrosion mechanism	Adaptable to rate measurements	Does not determine distribu tion and type of attack Analysis of corrosion products required

Consequently the search for a universal test has been abandoned.

However, a number of accelerated test procedures have been adopted for special purposes. They are particularly useful in production control testing and in the qualitative screening of various materials where experience has shown that a given test environment produces reasonably valid results.

What Corrosion Tests Mean

We shall not attempt to describe test procedures[1, 2, 3] in detail or even to review all of the common corrosion tests. Rather we shall comment briefly on the types of tests applicable to various problems and on significant trends in corrosion testing.

First a word about the many methods for evaluating and expressing corrosion effects. These involve principally gravimetric, electrochemical, microscopic or physical property measurements as summarized in Table I.

Often two or more methods are used concurrently to enable better interpretation of results. Thus the microscope is a valuable auxiliary tool in nearly all corrosion studies. Metallographic examination can show directly the progress of corrosion, the extent of selective attack and pitting and other effects difficult to measure by other methods.

For design purposes, test results must be expressed in definite physical terms. When corrosion is uniform and occurs at reasonably constant rate over a fairly long period, reporting results in terms of average weight-loss or penetration rate is valid.

The usual units are milligrams per square decimeter per day (mdd.) or inches per year (ipy.). The latter unit permits a quick mental estimate of the probable life of a structure of known thickness. Allowance can be made for pitting by reporting maximum penetration as well as average penetration for the period of test. Speller[3] defines pitting factor as the ratio between maximum and average penetration.

In types of attack where weight-loss is not significant, the harmful physical effects of corrosion may be expressed better as change in some key physical property such as hardness, tensile strength or fatigue limit. Whenever possible, corrosion-time curves should be reported to prevent potentially-dangerous extrapolation of average rates.

In finding a suitable material for a particular service or of delineating the environments which a given material will withstand, it is almost

	Application	Advantages	Limitations
Electrochemical Single electrode potential	Study film formation and breakdown at a metal surface	Distinguishes between anodic and cathodic control Measures electrochemical driving force	Does not measure extent or rate of attack Requires careful interpretation
Potential difference between unlike metals	Study galvanic effects	Measures relative tendency to corrode	Qualitative only
Shorted-cell current measurement	Measure extent of corrosion relative to standard noble metal	Simplicity	Errors from electrode spacing solution resistance, unnatural deposit of corrosion products
Anode and cathode polarization	Study galvanic and concentration cell corrosion Determine total polarization current	Yields semi-quantitative estimate of corrosion rate	Does not measure distribution of attack
Film resistance measurement	Determine film penetrability	Qualitative indication of film breakdown in different environment	Interference of alternate reactions May measure decomposition potential
Optical inspection	Study growth of surface films	Non-destructive, continuous measurement	Complex apparatus Difficult interpretation
Environment analysis	Study product contamination from corrosion in service tests Follow relative corrosion of metal components in laboratory tests	May be necessary for product specifications Applicable to trace quantities Useful in liquid metal corrosion studies	Does not show distribution of attack on metal. Material balance required for liquid metal corrosion.

always fruitful to consult the extensive literature[2, 4, 5] on corrosion. In most cases, this search narrows the choice considerably.

Initial qualitative laboratory tests simulating service conditions should then be made in as simple a manner as possible. Finally quantitative corrosion rate measurements on the few most attractive materials can be made by using service tests in actual or pilot-plant equipment.

Use Correct Test Methods

Regardless of the specific measuring technique or test procedure, there are some general criteria applicable to planning and carrying out a good corrosion test. These criteria are summarized in Table II. Most of those in the table apply to other tests of engineering tests as well. Unless the criteria are strictly observed, we can readily get meaningless results.

Specimen selection and preparation are especially important in corrosion testing. First, we must be certain that the specimens are truly representative of the material under test and that they are of the proper size and shape. Second, a sufficient number of specimens must be prepared to permit proper replication of results and, if necessary, the use of control specimens or blanks.

Third, the specimens must be properly cleaned, prepared and preserved until the test begins. Details of various cleaning methods[1, 3] are covered in the literature. Upon completion of the test, prescribed techniques for specimen cleaning and removal of corrosion products must be followed carefully if weighings and other measurements are to be accurate.

In selecting experimental conditions and designing equipment, consult pertinent literature and previous experience keeping in mind test objectives. Next, build and operate test equipment so that it withstands the experiment. We must be careful that equipment corrosion or malfunction does not contribute extraneous effects to the data. Finally, in analyzing and interpreting the data, use proper techniques and principles. Wherever possible, avoid empiricism and apply fundamental principles.

Several of the accelerated corrosion tests originally proposed for all-purpose use are still widely employed as arbitrary performance standards in both government and industrial specifications. The best known is the salt-spray test in

Criteria for Corrosion Tests, Table II

- Proper selection and preparation of test specimens.
- Selection of experimental conditions. Corrosive environment, temperature, duration of exposure.
- Design and construction of equipment.
- Proper conduct of experiment. Control of process variables. Orderly collection of data. Thorough cleaning of specimens. Proper evaluation of test results.
- Analysis of data Technical and statistical.
- Interpretation and correlation of results.

which specimens are exposed to fine spray or mist of sodium chloride solution in a closed chamber at constant temperature.

Fog particles which settle upon the inclined test surfaces constantly replenish the corrosive solution. The extent and nature of corrosion after a specified exposure period serve as an index of quality. Corrosion acceleration[5] in this test is believed to result from continuous replenishment of oxygen in the solution film.

Customary specifications [6,7] call for 95 F. and 20% sodium chloride solution, although less concentrated solutions are sometimes used. Construction and dimensions of the test chamber are not rigidly specified. However, a baffle is required to prevent direct impingement of spray on the samples. Test results are sensitive to temperature, but not to salt concentrations over the range from 3 to 20%. Oxygen solubility in 20% solution is less affected by temperature than in less concentrated solutions.[8] Nozzle clogging restricts use of more concentrated solutions.

Although vaguely similar to the atmosphere encountered in severe marine exposures, the artificial environment used in salt-spray tests should be regarded entirely as an arbitrary standard widely accepted as a matter of convenience and custom.

A number of variations and modifications[1] including intermittent operation, acidified solutions and different salts have been tried with varying degrees of success. McMaster[8] has evaluated several of these modifications and compared typical results in terms of a performance index number.

Recently the General Motors Corp.[10] adopted a new salt-spray formula containing 5% sodium chloride and 0.04 oz./gal. of cupric chloride. The solution is maintained at a pH equal to 3.2 and is sprayed at 120 F.

Immersion tests are also popular in laboratory testing. Various types of total, partial and intermittent immersion apparatus [1,2,11] are used in accelerated tests. Corrosive media range from sea water to acid, base or salt solutions. Again these arbitrary procedures for material evaluation depend upon empirical standardization and trade acceptance. However, immersion tests are satisfactory for routine checking on a mass production basis. Kutzelnigg[12] gives an extensive review of accelerated corrosion testing practice in Europe.

Consider Special Tests

A trend in laboratory testing is the perfection of special property tests applicable to specific materials. These tests aid in the development of new alloys and in controlling production quality. Such tests do not attempt to measure the service life of a metal but rather to indicate its tendency toward special types of corrosion.

In these tests, we often employ mechanical property measurements as criteria of damage. Included in this type are corrosion fatigue tests, stress corrosion tests and chemical tests. For example, susceptibility of brasses to dezincification[9] is indicated by reduction of tensile strength upon exposure to cupric chloride solution. Tendency toward season cracking[13] in brass is detected by cracking upon brief exposure to a solution containing 10% mercurous nitrate and 1% nitric acid.

The popularity of stainless steels has drawn attention to various tests for stress corrosion cracking. Originally test equipment[2] in this area was large and expensive. Present procedures emphasize use of multiple small samples and simple loading techniques such as U-bend specimens loaded by means of a bolt through the open end. Williams[14] used this type of specimen in studying chloride and caustic stress corrosion of austenitic stainless steels.

In two recent articles, Fraser[15] discusses the general requirements for a successful stress corrosion testing method. He develops the concept of critical strain at which the probability of failure is one-half. This new approach employs a statistical method called probit analysis.

For several years the chemical industry has employed a number of qualification tests in its specifications for stainless steels. Oldest of these tests is the boiling nitric acid test.[2,16] In this test, specimens are immersed in boiling concentrated nitric acid for five successive 48-hr. periods. Corrosion is measured by weight loss. Constant rate of loss is indicative of proper heat treatment and acceptable stress corrosion resistance.

A test for the tendency of stainless steels to undergo intergranular corrosion depends on the highly selective attack at susceptible grain-boundary material by boiling solutions of cupric sulfate and sulfuric acid. Procedure in this test[17] calls for exposure of specimens to fresh solutions for several successive 72-hr. periods. Failure is indicated by the appearance of cracks upon subjecting the specimen to a 180° bend over a radius of half the specimen thickness.

Since these tests are time consuming for routine use, the ASTM is considering an alternate test based on electrolytic etching[18] with oxalic acid. Examination of the specimen reveals precipitated carbides through visible roughening of the surface. The proceedings[19] of an ASTM conference summarize the advantages and disadvantages of these faster tests.

Undoubtedly, the qualification tests have helped considerably in developing better alloys, improved heat treating procedures and standardized production techniques. However, the empirical nature of these tests gives only limited explanation of corrosion fundamentals.

Our knowledge of the environmental conditions conducive to stress corrosion crecking is still limited. We know that transgranular cracking of austenitic

stainless steels occurs when the alloys are stressed in tension and simultaneously exposed to slightly acid chemical media containing chlorides.

Uhlig and Lincoln[30] recently published the results of an extensive study of type 304 stainless steel behavior in magnesium chloride solutions. Their study gives some pertinent conclusions regarding crack propagation rates and mechanism and notes that cracking can be prevented by cathodic protection. More fundamental work of this kind is needed for a better understanding of this type of attack.

Field Evaluation Tests

Long-term outdoor exposure tests are widely used for field evaluation of both metallic and nonmetallic materials. Several major manufacturers maintain test stations at both rural and industrial locations to evaluate the effects of different atmospheres. Metal specimens for atmospheric exposure are commonly 4 × 6 in. The specimens inclined at 30° to the horizontal and facing south[2] are supported on racks by means of ceramic insulators.

The largest corrosion testing station of this kind is operated by the International Nickel Co. near Wilmington, N. C. Sea water corrosion is studied at Wrightsville Beach and atmospheric corrosion at Kure Beach. Several laboratory buildings provide for a broad spectrum of corrosion testing methods.

Large numbers of specimens have been tested and much valuable data collected at this station in the 30 yr. of its operation. Its operation is summarized by Fontana[21] and in publications of the International Nickel Co. A typical series[22] of atmospheric exposure tests evaluating the corrosion protection afforded to steel by tin-nickel electrodeposits; and a semiquantitative method for rating the results are described by Lowenheim and coworkers.

Although we can predict the tendency of metals to form galvanic couples from tables of oxidation potentials, in practice the actual rate is set primarily by environmental factors. Consequently galvanic couple tests have become an important aspect of field and service tests.

Test methods[2,23,24] of varying complexity have been devised and are described in the literature. These range from simple rigs for coupling pairs of small metal specimens to electrical devices for measuring and recording potentials and currents continuously over an extended period. In all such tests it is important to expose insulated control specimens of each metal to the test environment, so that the extent of galvanic effects may be properly evaluated.

Corrosion at High Temperature

Corrosion testing at elevated temperatures has received relatively little attention in the past. It is becoming increasingly important as new processes employing severe conditions are developed. Several unique problems are involved in this type of testing including choice of container materials, proper control of temperature, selection of proper test duration and special safety precautions.

Greene[25] discusses these methods and presents examples of good and bad testing procedures. Reference to the literature cited in our earlier installment[26] on nonoxidative corrosion reveals some of the high temperature techniques used in corrosion studies with liquid metals. The ASTM has adopted some general practices in this area,[2] but usually each test problem presents sufficiently unique requirements that meaningful standard tests are difficult to devise.

Since oxidative corrosion is essentially specialized electrochemistry, electrochemical techniques find important applications in corrosion testing. Such techniques are most useful for the study of fundamentals rather than for routine testing, although some years ago consideration was given to accelerated corrosion tests[1] based on impressed anodic currents. Localized potential and current measurements have long been used in studying electrode processes and still represent the principal tools in this area of research. Some of the common techniques and equipment[3] are described by Haring.

In a comprehensive article Stern[27] discusses the theoretical and practical aspects of determining corrosion rates from the initial linear portions of polarization curves. This straightforward technique can supply valuable data for a given metal on environmental effects such as temperature, velocity, composition and influence of inhibitors. The technique also yields comparative corrosion rates of different metals in the same environment. In another study Pryor and Keir[28] used corrosion current and potential measurements to evaluate polarization phenomena in aluminum-steel and zinc-steel couples.

A number of interesting electrochemical studies of corrosion have come from Russia. Zhuk[29] suggests a method and apparatus for rapid comparison of corrosion resistance of metals in a given environment by comparing their polarization curves. Shatalov[30] classified electrode potentials for 16 metals according to degree of anodic control at various pH values. Rosenfeld and Pavlutskaya[31] developed a method for measuring polarization effects in thin electrolyte films on a metal surface. Their method provides a means of delineating the role of oxygen diffusion in electrode processes from data on the variation of potential with film thickness.

Conductance measurements in corrosion cells can also be used to follow corrosion processes. This technique finds its widest application in soil corrosion studies where conductivity plays an important part in determining corrosion rate. Riordan[32] published a comprehensive discussion of basic concepts and practical aspects of soil corrosion field tests stressing potential and conductivity measurements.

An indirect electrical measuring technique has become increasingly

Accelerated Corrosion Tests, Table III

- Salt spray.
- Immersion methods.
  Total, partial or intermittent types.
- Corrosion fatigue.
- Stress corrosion.
- Chemical.
- Boiling nitric acid.
- Electrolytic etching.

popular for continuous monitoring[30,31,32] of corrosion in operating chemical plant and refinery equipment. A small probe made of metal foil or wire is inserted into the process stream. Corrosion of the probe is measured by noting the increasing in electrical resistance as cross section of the probe diminishes.

This technique reveals nothing about the corrosion mechanism. However, it serves the same purpose in service testing as sample metal coupons and can be used more rapidly and conveniently. It also serves to study variations in either materials or environments. However, care must be exercised in making the probe so that measured corrosion rate is representative of the material and not the fabrication technique.

As in other field of technical research, statistics is making important contributions to the advancement of corrosion testing. It is not our purpose here to discuss the techniques of statistical analysis. Statistical analysis has received considerable attention in the engineering literature, notably an excellent basic presentation[26] by Volk. The general use of statistical methods in corrosion testing[2] is discussed by Eldredge.

Briefly, we will simply point out that corrosion data can be rendered more meaningful and that more valid conclusions can be drawn from repetitive measurements through the use of mean values, measures of deviation, confidence tests and analysis of variance. Hence, much of the uncertainty in sampling can be eliminated and proper control of test conditions is facilitated. Also spurious results are readily detected and much of the drudgery of multiple testing is minimized.

The recent work of Fraser and coworkers[14] illustrates the potential of statistics as a means of developing new criteria in corrosion testing. Hromi[37] discusses the usefulness of statistics in the design of corrosion experiments. Aziz[38] applies the statistical theory of extreme values to the analysis of maximum pit depth data. We can expect that within the next few years statistics will continue to develop as a powerful tool in corrosion research.

We shall also mention some new experimental techniques which are likely to aid in the advancement of corrosion research. Electron diffraction and electron microscope studies as reported by Gulbransen[39] promise new insight into the structure of metals, oxides and films. Radioactive tracers make possible more fundamental rate and mechanism investigations. Smith and Hill[40] employed this method to study zirconium corrosion.

Single crystals of metal can now be used to study variation in corrosion rates[41] at different crystal faces as in the work of Buck and Leidheiser. The effects of intense radiation on corrosion processes and the corrosion resistance of materials of construction represent a new field of study which is likely to grow in importance as applications of nuclear energy increase.

In concluding this series, it is pertinent to comment on the present status of corrosion knowledge and the needs for future research. While much is known about the electrochemical nature of oxidative corrosion, there are many gaps particularly in our knowledge of rate processes. The whole area of polarization—particularly passivity and overvoltage—needs further fundamental study.

The principles of mass transfer and kinetics, as employed in studying other process problems, can make substantial contributions to such study. The causes of pitting, stress corrosion and other specialized forms of attack are only superficially understood and need much more work.

Our knowledge of nonoxidative corrosion phenomena is even more limited. There must be more study of basic processes of attack and of mass transport rates and mechanisms in liquid metals, molten salts and similar environments.

LaQue summarized the situation very well at the AIChE Golden Jubilee Meeting.[42] He pointed out that in the past corrosion research has been largely empirical and has emphasized materials. Now we must have a more fundamental study of corrosive environments as a basis for further progress.

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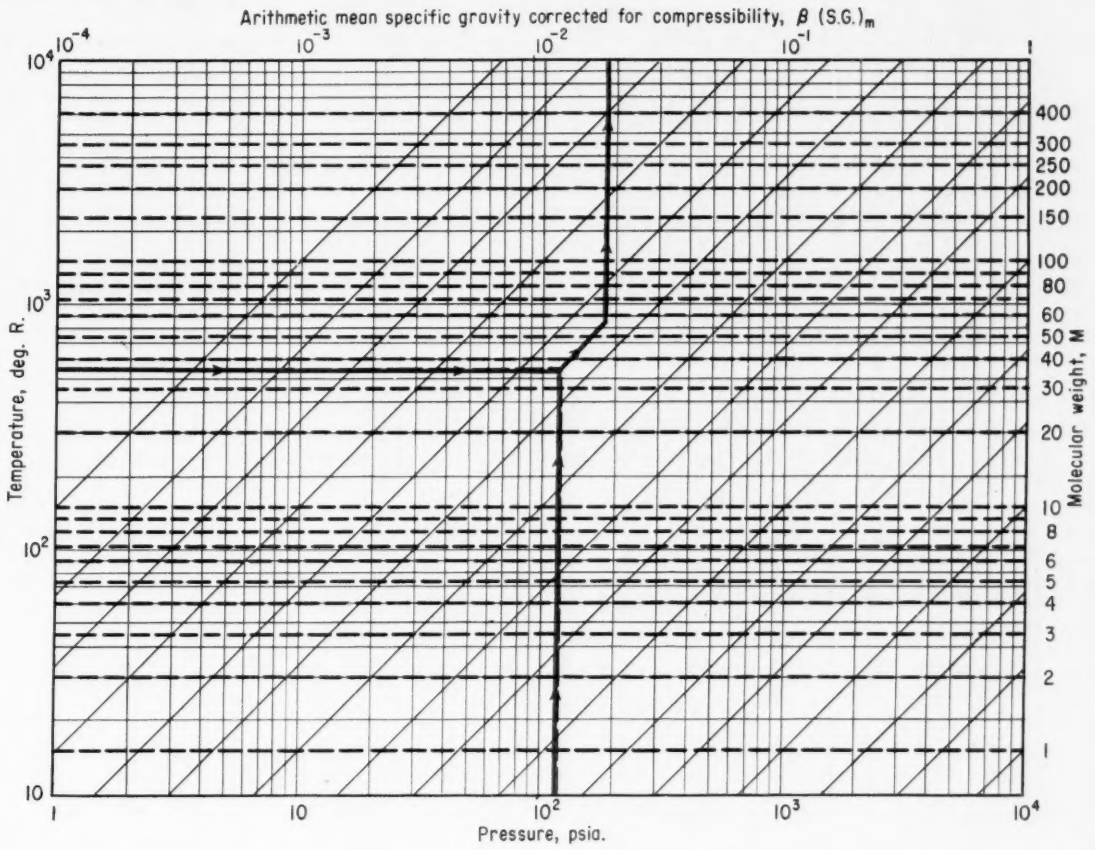
Chart Gives Arithmetic Mean Specific Gravity at a Glance



For Gases and Vapors . . .

Charts Give Tubeside Pressure Drop

. . . For Streamline or Turbulent Flow

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WHEN YOU have gases and vapors, calculation of pressure drop through the tubes of a heat exchanger is slightly different from calculations for liquids. When you have liquids, densities do not vary with travel through the tube, whereas for gases and vapors, density changes with length of travel.

However, Dodge[4] has shown that Fanning's equation may still be applied to gases and vapors provided that the arithmetic mean density is used.

Based on Fanning's equation (and using specific gravity referred to water, rather than actual densities), the design equation for the calculation of pressure drop through tubes in a tubular exchanger for turbulent flow conditions has been presented in this form:[3]

$$\frac{\Delta P'}{L} = \frac{6.85\,(W')^{1.8}\,(Z)^{0.2}}{10^9\,(D')^{4.8}\,(S.\,G.)} \qquad (1)$$

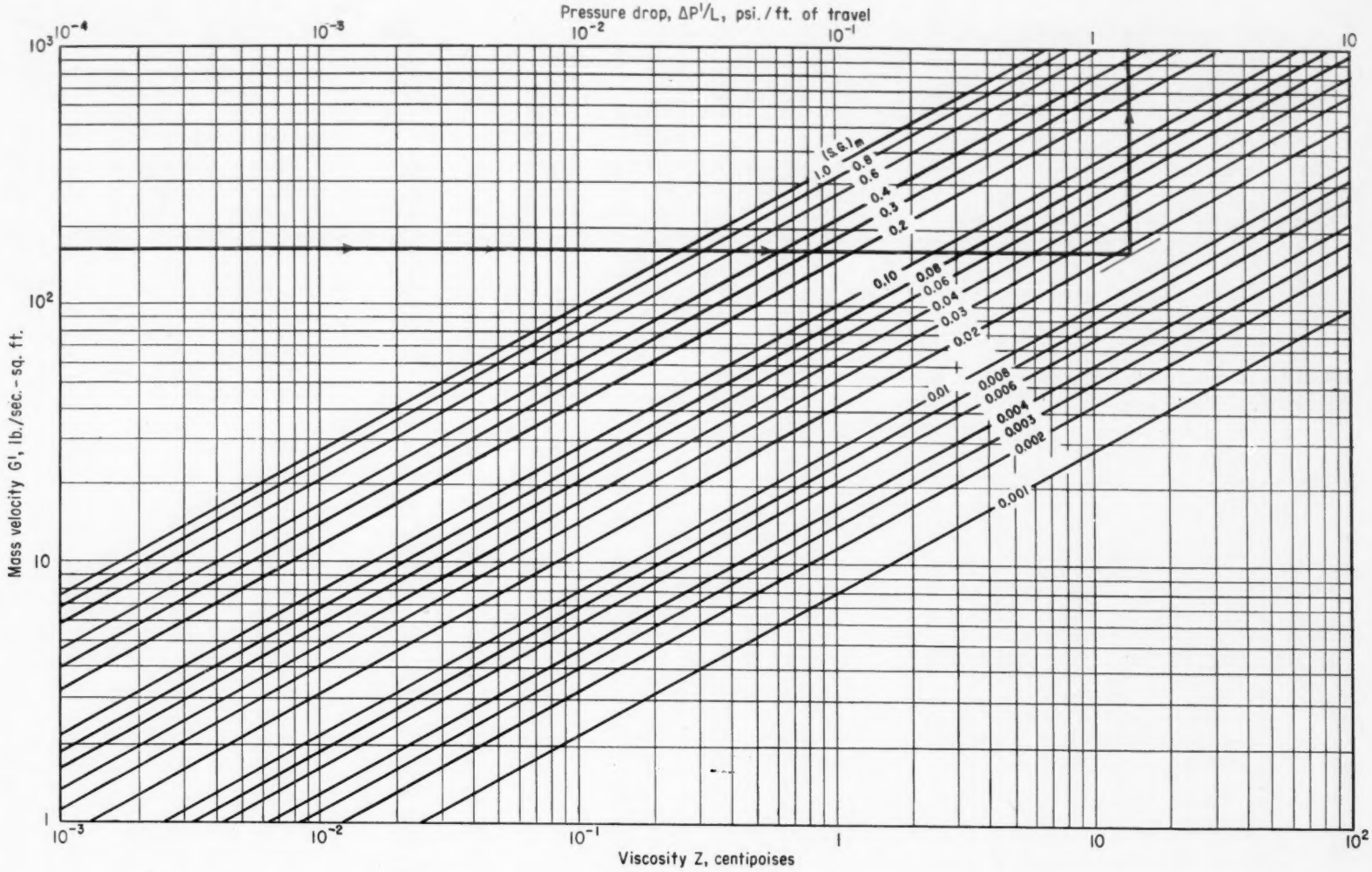
For streamline flow, the equation is:[3]

$$\frac{\Delta P'}{L} = \frac{5.46\,ZW'}{10^7\,(D')^4\,(S.\,G.)} \qquad (2)$$

Now, if we use the arithmetic mean specific gravity and change W′ to G′ using the following relationship:

* To meet your author, see *Chem. Eng.*, June 30, 1958, p. 140.

Use This Chart When You Have Gases or Vapors in Tubeside Turbulent Flow



Nomenclature

D'	Inside tube diameter, in.
G'	Mass velocity inside tube, lb./sec.-sq. ft.
L	Length of travel, ft.
M	Molecular weight of the gas, dimensionless.
P_1	Inlet pressure, psia.
P_2	Outlet pressure, psia.
P_m	Arithmetic mean pressure, 0.5 ($P_1 + P_2$), psia.
R	Universal gas constant, 10.73 psia./cu. ft.-lb. mole-°R.
$(S.G.)_m$	Arithmetic mean specific gravity of the gas referred to water, dimensionless.
T	Absolute temperature, deg. R.
W'	Unit mass flow rate, lb./hr., per tube, per pass.
Z	Viscosity, centipoises.
β	Compressibility factor.
$\Delta P'$	Pressure drop, psi.
ρ_m	Arithmetic mean density of the gas, lb./cu. ft.

$$W' = 19.6\,(D')^2\,G' \tag{3}$$

Then Eq. (1) becomes, for turbulent flow,

$$\frac{\Delta P'}{L} = \frac{1.45\,(G')^{1.8}\,Z^{0.2}}{10^8\,(D')^{1.2}\,(S.G.)_m} \tag{4}$$

and for streamline flow, we can use:

$$\frac{\Delta P'}{L} = \frac{1.07\,Z\,(G')}{10^8\,(D')^2\,(S.G.)_m} \tag{5}$$

We can now use Eqs. (4) and (5) to construct charts which give quick solutions for streamline and turbulent flow. However, note that the equations call for—and the charts are built with—values of arithmetic mean specific gravity of the gases or vapors referred to water.

This still leaves the problem of converting density to specific gravity. We have constructed the chart on p. 111 for the fast evaluation of arithmetic mean specific gravity. It is based on these equations:

$$\rho_m = (M/RT)\,0.5\,(P_1 + P_2)\,(1/\beta) \tag{6}$$

or,

$$(S.G.)_m = (M/RT)\,(P_m/\beta)\,(1/62.4) \tag{7}$$

where P_m is the arithmetic mean pressure.

If the pressure drop is not too great, the mean pressure will approach the inlet pressure, P_1. For design purposes, it's good enough to use the inlet pressure P_1 instead of P_m in Eq. (7), and that is how the chart was built.

Let's Try Two Typical Problems

Problem 1 (*Turbulent Flow*)—Find the tubeside pressure drop for a vapor ($M = 58$) flowing isothermally at 100 F. through an exchanger at a rate of 168,000 lb./hr. The exchanger has 300, ¾ in. × 14 BWG tubes arranged into two passes; tube length is 8 ft. Operating pressure is 120 psia. Assume that the vapor behaves as an ideal gas, and that it has a viscosity of 0.01 centipoise.

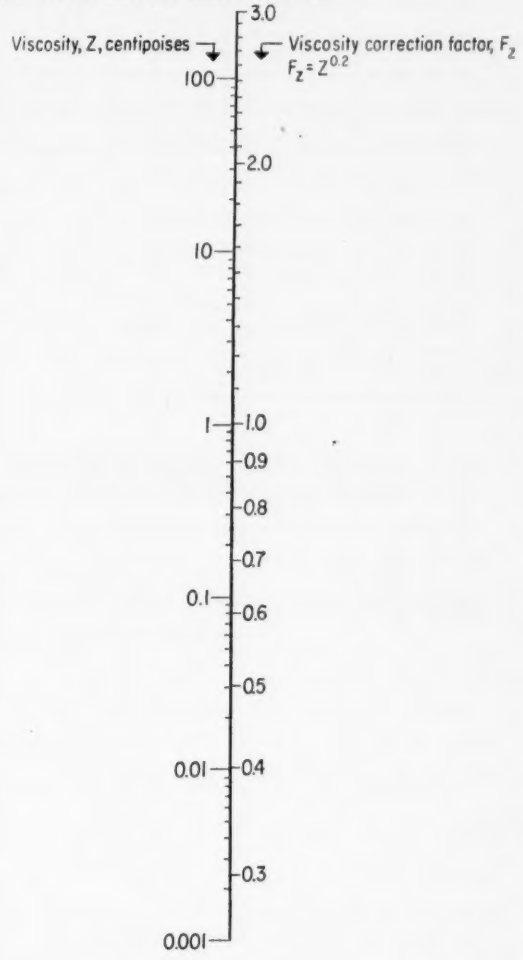
Step 1—Find the mass velocity. From Fig. 1 of Ref. 1, we know that $G' = 168$ lb./sec.-sq. ft.

Step 2—Using the chart given in this article, estimate the arithmetic mean specific gravity of the vapor referred to water. To do this, erect a line through the pressure of 120 psia. to meet the line drawn horizontally from the temperature of 100 F. + 460 = 560 R. Through this intersection, draw another line parallel to the 45-deg. guide lines, to meet a line drawn horizontally from the molecular weight of 58.

The abscissa of this last intersection, shown on the

Correct $\Delta P'/L$ for Viscosity Also

(Factors for tubeside turbulent flow)

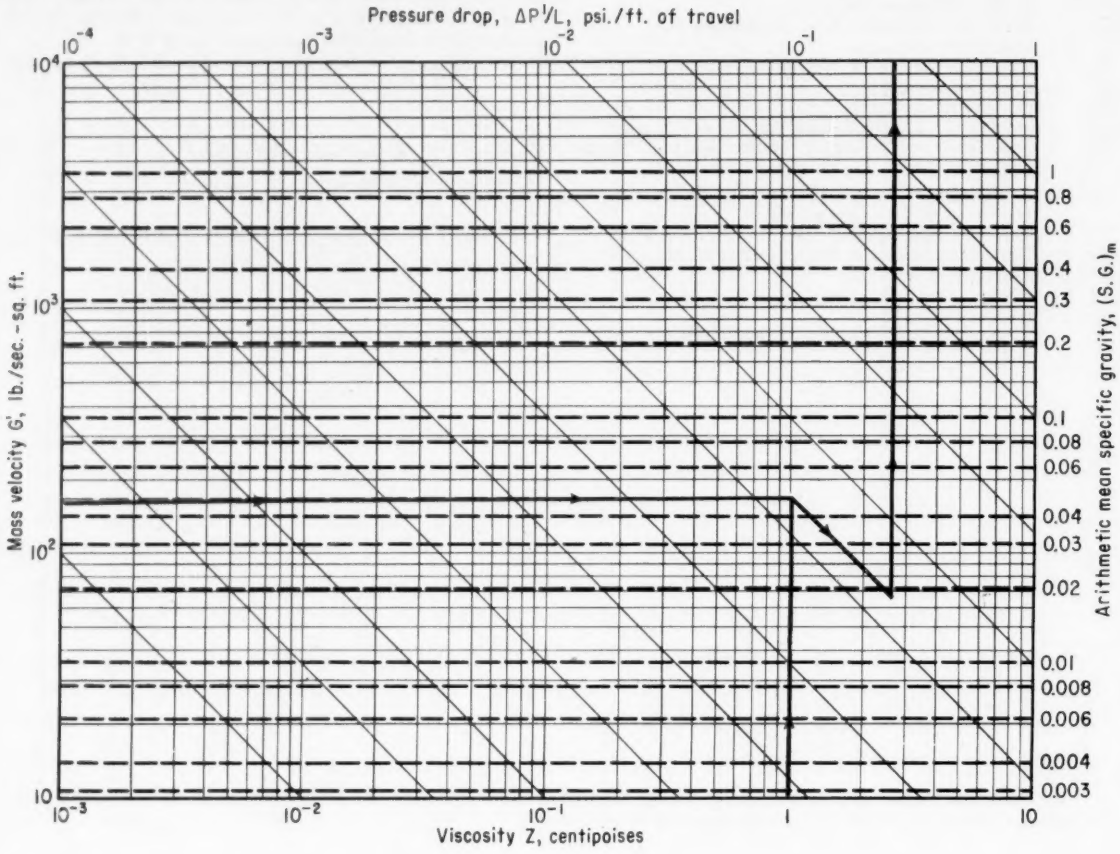


Correct $\Delta P'/L$ for Tube Size

(Factors for tubeside turbulent flow)

¾ in.	× 12 BWG	1.200
	× 14 BWG	1.072
	× 16 BWG	1.000
	× 18 BWG	0.940
1 in.	× 12 BWG	0.756
	× 14 BWG	0.703
	× 16 BWG	0.666
	× 18 BWG	0.636
1¼ in.	× 12 BWG	0.542
	× 14 BWG	0.513
	× 16 BWG	0.492
	× 18 BWG	0.477

For Tubeside Streamline Flow, This Chart Applies



Correct $\Delta P'/L$ for Tube Size (Factors for tubeside streamline flow)

¾ in. × 12 BWG..... 1.358	1 in. × 10 BWG..... 0.718	1¼ in. × 10 BWG..... 0.400
× 14 BWG..... 1.124	× 12 BWG..... 0.630	× 12 BWG..... 0.360
× 16 BWG..... 1.000	× 14 BWG..... 0.555	× 14 BWG..... 0.327

top scale of the chart, gives $\beta(S.\ G.)_m = 0.0185$. Since we assumed vapor behavior comparable to that of an ideal gas, $\beta = 1$ and for use on the following charts, $(S.\ G.)_m = 0.0185$.

Step 3—Find the tubeside pressure drop from the turbulent flow chart. Draw a horizontal line through $G' = 168$ to meet the arithmetic mean specific gravity line of 0.0185. The abscissa of this intersection, shown on the top scale as 1.4, is the uncorrected pressure drop per ft. of travel.

Multiply this value by the tube-size correction factor for ¾ in. × 14 BWG tubes, 1.072. Multiply also by the viscosity correction factor, 0.4.

Therefore, corrected $\Delta P'/L = 1.4 \times 1.072 \times 0.4 =$ 0.6 psi./ft. Total pressure drop is 0.6 psi./ft. × 8 ft. × 2 passes = 9.6 psi. If a safety factor of 1.25 is used, then tubeside pressure drop is 12.0 psi.

Problem 2 (*Streamline Flow*)—Find the isothermal pressure drop using the same conditions as in Problem 1, except that the viscosity of the gas is 1 cp.

Solution—Mass velocity is the same, $G' = 168$. $(S.\ G.)_m$ is the same, 0.0185. On the streamline flow chart, erect a line through $Z = 1$ to meet a line drawn horizontally through $G' = 168$. Through this intersection, draw a 45-deg. line to meet the S. G. line of 0.0185. The abscissa of this last intersection is shown on the top scale as 0.26 psi./ft. of travel. Multiply by the tube-size correction factor of 1.124 to get 0.293 psi./ft. of travel. For 2 passes, 8-ft. long, this would give a total pressure drop of 4.7 psi. A safety factor of 1.25 would raise this to 5.87 psi.

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2. Chen, N. H., *Chem. Eng.*, Sept. 22, 1958, p. 161.
3. Chen, N. H., *Chem. Eng.*, Oct. 6, 1958, p. 152.
4. Dodge, B. F., "Chemical Engineering Thermodynamics," p. 350, McGraw-Hill Book Co., Inc., New York (1944).

CE COST FILE

No. 10 Heat Exchanger Cost Estimations

H. J. DeLamater, Chairman, AACE Heat Exchanger Cost Committee

Cost of Basic Exchangers—All Steel TEMA Class R, 150 psi.

Floating Head Exchangers

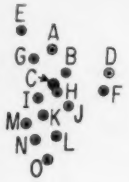
	Point
3/4" x 16' tubes, 1" □ pitch	A
3/4" x 16' tubes, 15/16" △ pitch	B
3/4" x 20' tubes, 1" □ pitch	B
3/4" x 20' tubes, 15/16" △ pitch	C
1" x 16' tubes, 1 1/4" □ pitch, below 1,000 sq. ft.	D
1" x 16' tubes, 1 1/4" □ pitch, 1,000 sq. ft. and above	E
1" x 16' tubes, 1 1/4" △ pitch, below 1,000 sq. ft.	F
1" x 16' tubes, 1 1/4" △ pitch, 1,000 sq. ft. and above	G

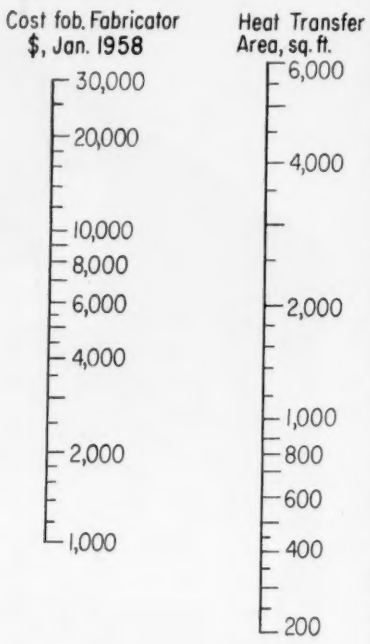
U-Tube Exchangers

1" x 16' tubes, 1 1/4" □ pitch	H
1" x 16' tubes, 1 1/4" △ pitch	I
3/4" x 16' tubes, 1" □ pitch	J
3/4" x 16' tubes, 15/16" △ pitch	K
3/4" x 20' tubes, 1" □ pitch	K
3/4" x 20' tubes, 15/16" △ pitch	L

Fixed Tube Sheet Exchangers

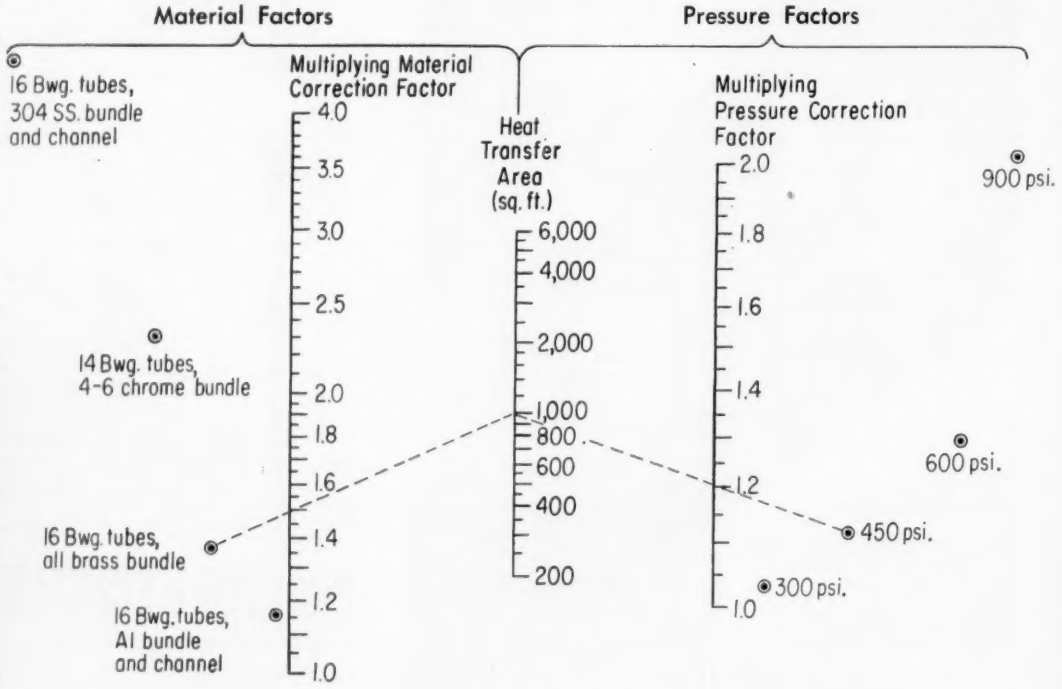
1" x 16' tubes, 1 1/4" △ pitch	M
3/4" x 16' tubes, 15/16" △ pitch	N
3/4" x 20' tubes, 15/16" △ pitch	O

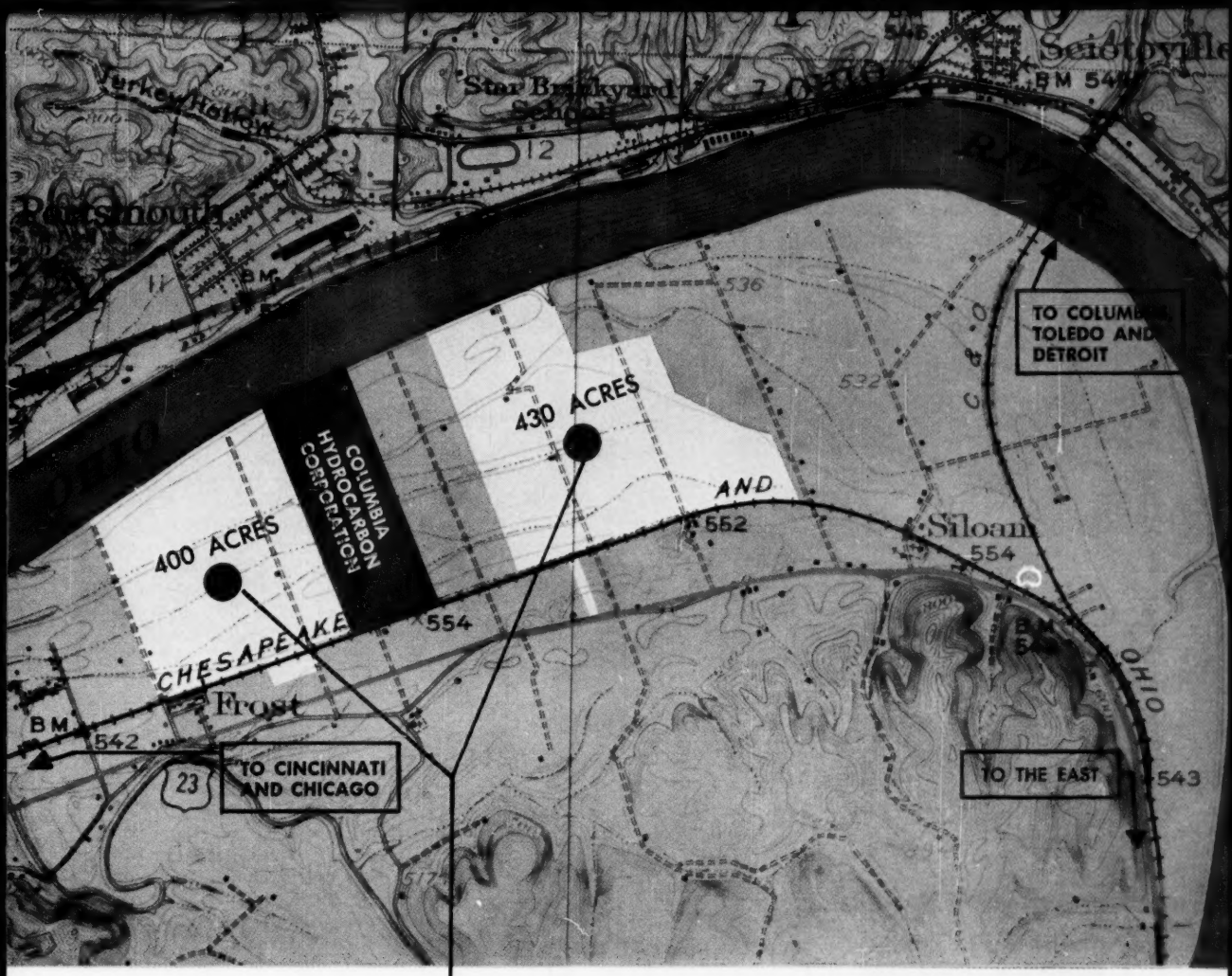




Cost of Other Exchangers

Multiply the basic exchanger cost above by the appropriate correction factor for other materials of construction and pressures.





AT SILOAM, KENTUCKY

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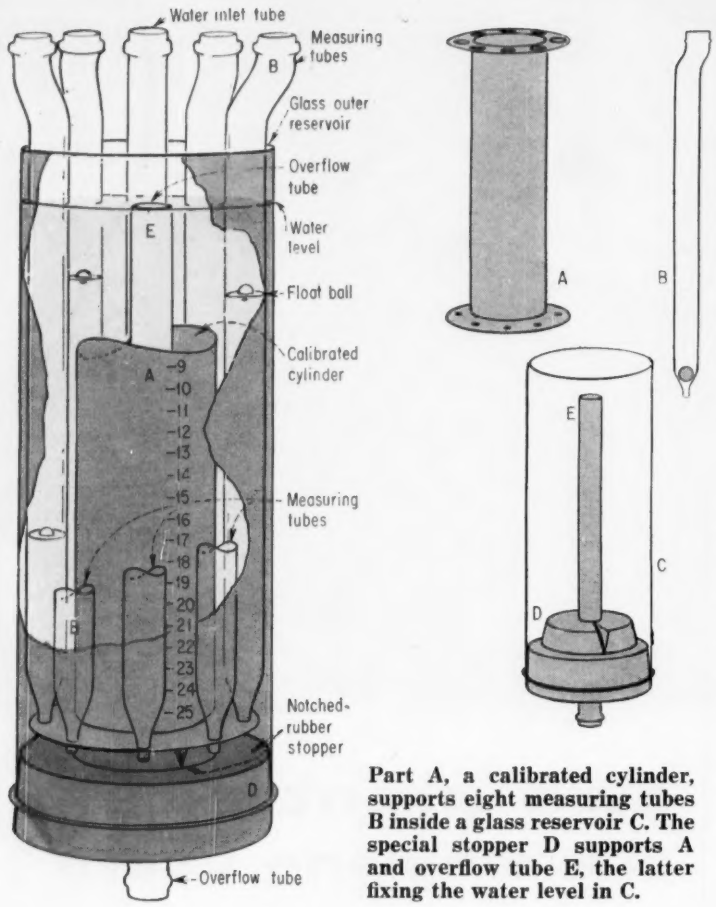


Part A, a calibrated cylinder, supports eight measuring tubes B inside a glass reservoir C. The special stopper D supports A and overflow tube E, the latter fixing the water level in C.

Save space, simplify reading with . . .

Cylindrical Multi-Manometer

★ **Winner of the November Contest**

Gerhard Hübner

Chemical Engineer, Burghausen/Obb., Niedernweg 5, Germany.

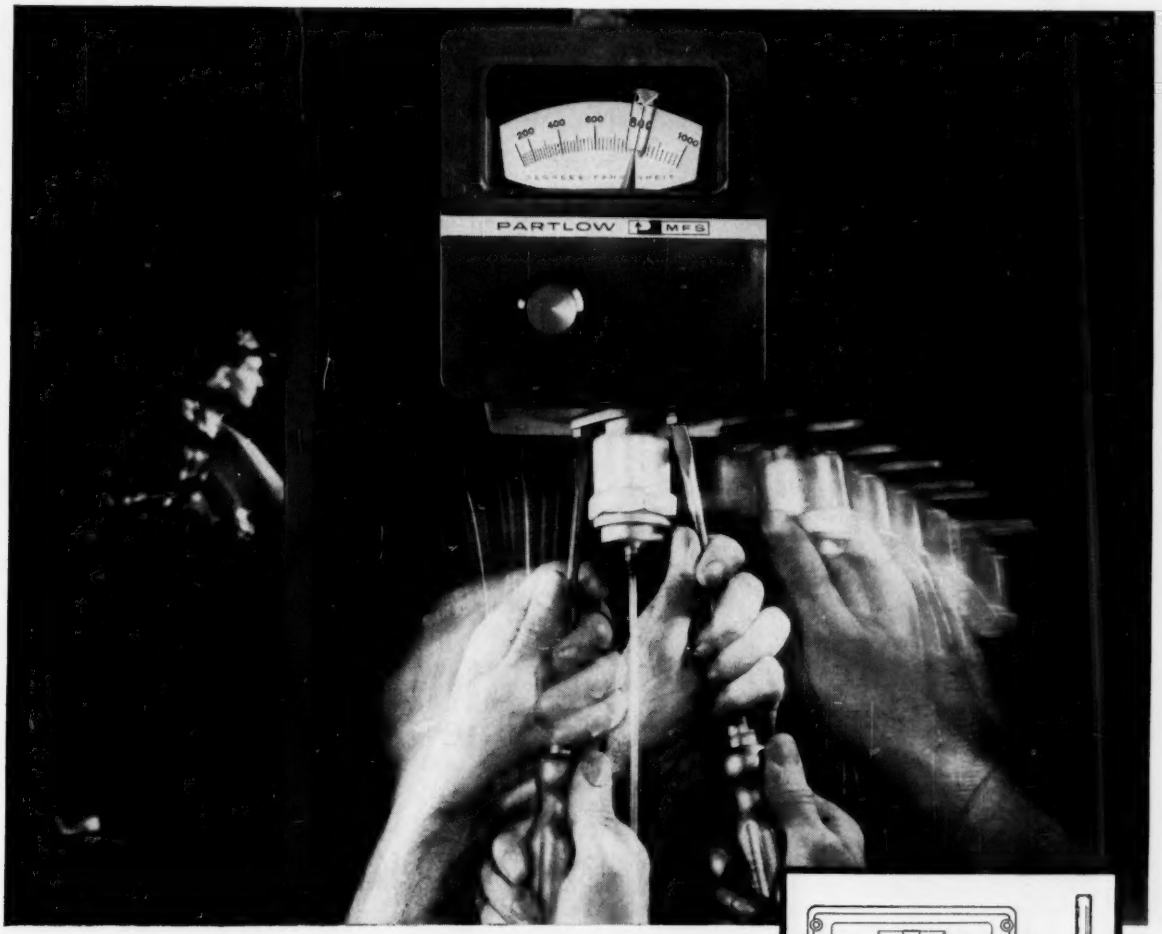
Illustrated above is a simple type of multiple manometer which I have found useful in measuring pressures and differential pressures in pilot plant work and elsewhere. This device has two main advantages: it is very compact, and it employs a fixed zero so that, in measuring a single pressure, it is necessary to read the level in only a single tube. In contrast, the difference between the levels in two legs must be read in using a U-tube manometer. In reading differential pressures, of course, it is still necessary to read the levels in two tubes with the new manometer, then take their difference.

The basic idea involved in the new manometer is the connection of several measuring tubes to the same constant-level reservoir, which serves as the second leg for each of the measuring tubes. This can, of course, be done in a number of ways and the principle itself is not new. The novelty lies in the particular simple way in which such an arrangement is achieved, and in the compactness and ease of reading which result.

A large diameter glass tube (a 50-mm. tube, for example, will take care of eight measuring tubes) is supported vertically and closed at the bottom with a bored rubber stopper cut as shown. Resting on the stopper is a cylinder of metal, sheet plastic or glass which should be proof against corrosion and which can be engraved or otherwise marked with a scale around the entire circumference. In the design shown the metal cylinder is flanged at the ends to support the eight measuring tubes, but there are many other ways of holding these tubes lightly in place.

The measuring tubes are slightly tapered at the bottom and are bent at the top to facilitate making connections. Each tube except the eighth—farthest from the observer—contains a small float which may be of wax, a plastic such as polyethylene, or a hollow glass ball. These floats facilitate reading the liquid levels in the measuring tubes.

The eighth tube is used for introducing water continuously into the reservoir. The sketch also shows a single central tube with its upper end at the desired reservoir level. In use, a small stream of water is allowed to flow continuously in through the eighth tube, overflowing constantly through the central outlet. In this way the manometer acquires a constant zero, making



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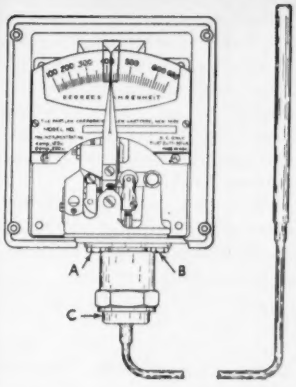
Simplicity in the Partlow, for one thing, means that the control element can be changed *at the job site* in a matter of minutes with no other tool than a screwdriver . . . "Down time" is cut to an absolute minimum!

And simplicity in the Partlow also means the complete elimination of fussy electronic gadgets, delicate levers, hairsprings and other accessories that have a tendency to break down at the first trace of jar or jostle. Partlow controls are famous for their unfailingly accurate performance even under the most adverse operating conditions.

If you use or manufacture process equipment within the −30° to 1100° F. range, there's a Partlow pneumatic, electric or self-contained gas control (recording, indicating or non-indicating), to fit your application *precisely*. For details, write The Partlow Corp., New Hartford, New York. Dept. E-159.



Diagrammatic view of the new MFS reveals "quick-change" feature common to all Partlow controls. In case of damage, merely unscrew at points (A) and (B), and remove element (C) from case. Reverse this process, and your Partlow is ready to resume operation.

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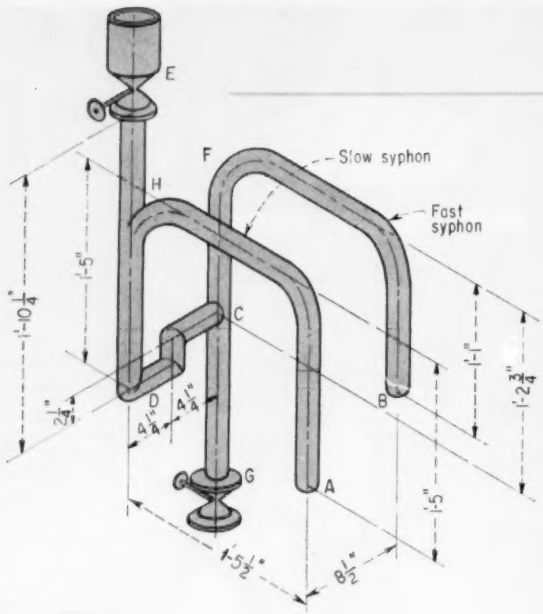
TEMPERATURE CONTROLS



★ $100
Annual Prize Winner for 1958*

Tank Siphon Holds Its Prime

C. F. A. Roberts
Superintendent, Plant Investigations Dept., Orr's Zinc White Ltd. Widnes, Lancs., England.

It is often necessary in chemical plant operations to have a means of maintaining liquid level in a tank between working limits. This usually presents no problem when new equipment is being installed, but may involve a difficult situation in modifying existing equipment, especially if glass- or rubber-lined.

The sketch above shows an ever-primed siphon which is easy to construct and suitable for existing tanks.

After the tank has been filled the siphon is primed by filling through valve *E*, with valve *G* closed. Closing valve *E* and opening valve *G* then starts the siphon, as long as the tank level is above *B*. Priming is easier if the siphon ends are plugged during filling. When the level drops to *B* the fast siphon *BFC* breaks and empties. For a short time, or until the level drops to *C*, the slow siphon will continue a slow discharge through *AHDC*. When the level reaches *C*, the slow siphon will cut off, but will hold its prime due to the liquid seal at *D*.

When further liquid is added to the tank and the level rises above the level of *C*, slow flow will resume through the slow siphon, the rate of flow increasing as the level continues to rise. At some level a short way above *B*, the flow will have increased enough so that the liquid discharging at *C* into the riser *FG* will act like a laboratory water aspirator and will create enough vacuum to prime the fast siphon *AFC* rather suddenly. At this point the entire section *BFCG* will be full and rapid siphoning will resume. The cycle of operations thus starts all over again.

The dimensions shown have worked satisfactorily in practice, though considerable latitude is possible. However, I do not recommend a larger tubing diameter than 2 in., while dimension *EH* should be as short as possible. The lower that end *B* is, the sharper will be the cut-off action of the siphon, but the siphon will not work at all if *B* is lower than *D*.

* This article, condensed from the Oct. 6, 1958, issue, has been selected by the editors as the best monthly Notebook winner published in 1958. The author will therefore receive an additional prize of $100.

MANOMETER, *cont. from p.* 118

it unnecessary to read the reservoir level.

To use the manometer, the measuring tubes are connected at their upper ends to the several sources of pressure. These may be static pressures at various points in equipment; the pressures up- and downstream of differential producers such as orifice plates or venturis; or the pressure head necessary to bubble an inert gas through a dip pipe for determining the depth of liquid in a process or storage vessel. If the vessel itself is under pressure, then one tube can measure the vessel static pressure while another measures the liquid head, plus the static. Their difference then measures liquid head alone.

In case of over-pressure, the floats serve as check valves to help prevent gas blowing into the reservoir. They will not be completely tight but will considerably throttle the flow. If a flammable or poisonous gas is being measured, then a small flow of inert gas introduced into the pressure connection above the manometer will avert any hazard from over-pressure.

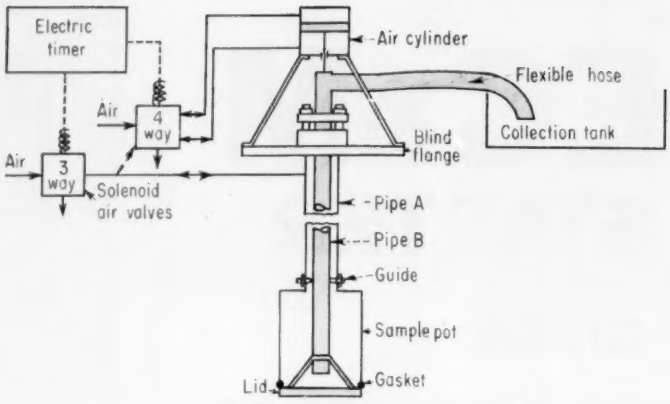
This arrangement has certain limitations, as well as a number of other advantages. The constant reservoir level is achieved simply by the use of flowing water so the design does not lend itself well to the use of other manometer liquids. That means, for instance, that liquid seals may be necessary sometimes.

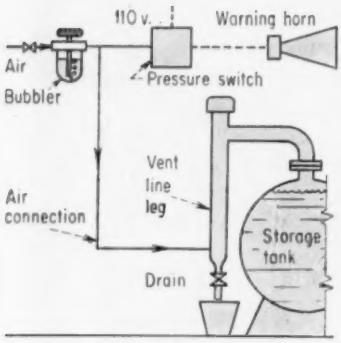
Furthermore, the pressure head that can be measured is limited by the height of water column that can be used in this instrument. In a differential pressure application, for example, each pressure is measured separately against atmospheric pressure as a standard, so that the static pressure cannot be higher than the available water column. Instead, if one used a U-tube for such an application, the static pressure would not have to be measured as such, but only the difference between up- and downstream pressures. Normally a water column height of perhaps 6 ft. would be about the greatest feasible for this

instrument, corresponding to a maximum measurable pressure of about 2.6 psig.

Another limitation is that the present design is not adapted to handling negative pressures of more than 1 or 2 in. w.c. However, the design could be modified to handle negative pressures.

Some of the other advantages of the design include ease of reading and of correlating several readings in various measuring tubes. Materials requirements are simple and the instrument is easily cleaned.





Vessel Overflow Sounds Warning Horn

Paul E. Kline
Dow Chemical Co.
Midland, Mich.

Sketched above is a reliable and easily assembled device to warn of liquid overflow from storage tanks or process equipment.

The idea is to connect an air bubbler into the vent-line leg so as to introduce a small stream of air. When an overflow occurs, the liquid backs up in the vent-line leg and puts air pressure on the air-operated mercury switch so as to sound the alarm. Overflow material can be caught in a bucket and can thereby be saved. Meanwhile, the condition responsible for the overflow can be quickly corrected.

This simple warning system has saved our plant many times the cost of its installation by stopping expensive overflows. At the same time it has eliminated a potential safety hazard by preventing large hydrocarbon spills.

Timer Controls Pneumatic Sampler

Jack N. Cramer
Assistant Instrument Supervisor, Scott Paper Co., Everett, Wash.

Our problem was to sample waste water in a large, partially filled sewer line, 10 ft. below ground level. This had to be done at regular intervals to determine wood fiber losses. It was complicated by the fact that tidal action caused the level in the sewer to rise and fall, causing different sized samples with conventional samplers, even though the flow remained relatively constant. Also, the effluent occasionally contained knots or chips which tended to clog pumps or obstructions in the sample line, leading to plugging and high maintenance costs.

The sampler sketched above solved these problems. It has but one moving part, operates on air pressure, and is automatically controlled by an electric timer.

It consists of a 1¼-in. outer pipe *A*, through which runs a ¾-in. inner pipe *B*. Pipe *A* is welded at the top to a standard blind flange. Pipe *B* is secured to an air cylinder at the top, and to a lid for the sample pot at the bottom. Pipe *A* has an enlarged 6-in. portion at the bottom, serving as a sample pot. Pipe *B* passes through the flange and is guided at the bottom so it can slide inside pipe *A*.

The sampler is installed through a manhole and extends into the sewer far enough to immerse the sample pot when the tidal level is low. If a sample is taken when the level is high, above the top of the sample pot, the small concentric area between pipes *A* and *B* will be filled but the extra sample volume so secured will be small in comparison with that of the pot so it will not appreciably affect the size of the sample.

The sampler works as follows: An electric timer energizes two solenoid air valves. The first operation is to energize the four-way valve to admit air above the piston and force pipe *B* down and open the sample pot. Liquid fills the pot and the timer then de-energizes the solenoid to move the piston upward and close the sample pot. Then the timer energizes the three-way solenoid, which puts air pressure between pipes *A* and *B*, thus padding the top of the liquid and forcing it out through pipe *B* and into the collection tank. The solenoid then de-energizes and vents the pressure line to atmosphere so the pot will fill on the next cycle. The timer can be set to repeat the cycle at any desired intervals.

Since this sampler has no pumps or obstructions in the sample line, plugging and maintenance are minimized.

NEXT ISSUE: Unconventional Vessel Heads Save Cost

By J. Klengen, Winner of the December Contest

★ How Readers Can Win

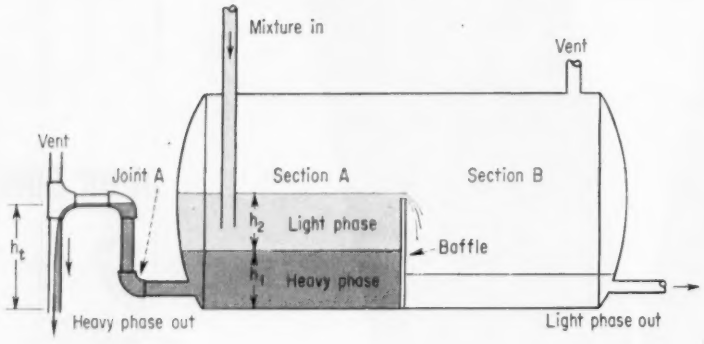
$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable non-winning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.



Simple Method for Interface Control

Donald C. Dingwall
Research and Development Engineer, Dow Chemical Co., Freeport, Texas.

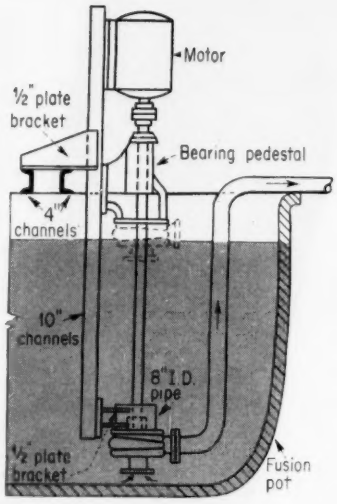
Illustrated above is a simple interface controller or separator for use on immiscible liquids at atmospheric pressure. It operates on the difference in specific gravity of the two phases.

The liquid head ($h_1 + h_2$) of the two phases in the drum is balanced against the liquid head of the heavier phase (h_t) in the underflow leg. Because of the fixed heads, h_t and ($h_1 + h_2$), the interface level adjusts itself at all times so that the total head of the two phases in Section *A* will equal the head in the leg. Therefore, the interface level will remain constant.

When the specific gravities of both phases are known, the exact height of h_t can be calculated. However, the simplest way for determining h_t is to make the leg assembly slightly longer than necessary. Then, when the separator is put into operation, the leg assembly is rotated around Joint *A* to an angle which will give a height of h_t which will put the interface where desired.

For proper operation, the level in Section *A* of the drum must remain constant. Therefore, it is important for the level of the light phase in Section *B* to remain below the baffle.

This apparatus is particularly suited to systems such as oil and water where the specific gravity difference is more than 0.1.



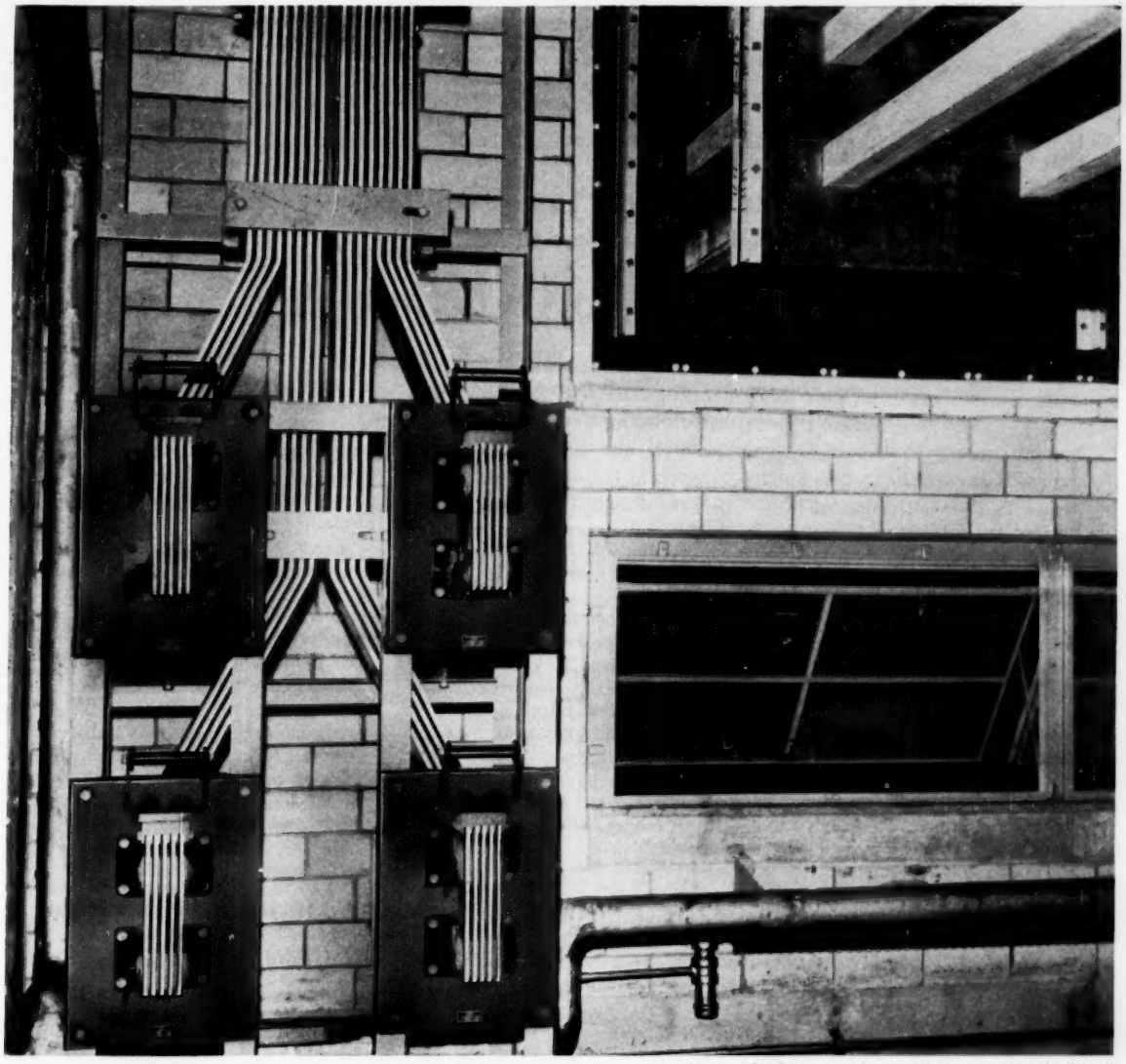
Standard Pump Converted For Submerged Operation

David Wittenberg
Engineer
Kiryat Motzkin-Haifa, Israel

Not long ago I had the problem of withdrawing fused caustic soda at 500 C. from a direct-fired fusion pot 7 ft. in diameter and 4 ft. deep. The pot had no bottom outlet and efforts to empty it with an ordinary centrifugal pump proved futile.

The answer seemed to be a submerged pump but one could not be obtained in the local market. So, I converted a standard centrifugal pump of the separate pedestal type for submerged operation as shown above.

In its original form the pump (shown dotted) was demounted from the bearing pedestal and provided with a shaft about 3 ft. longer than the original shaft. A new bracket was made from a short length of 8-in. pipe welded to a flange which was then bolted to the back of the pump casing. The motor, bearing pedestal and the new pump bracket were then properly aligned and bolted to a 10-in. channel. A second bracket was welded to the channel and bolted to 4-in. channels which supported the assembly vertically in the pot and were themselves clamped to the pot rim. With submerged operation, no packing gland was necessary.



Alcoa Aluminum Bus Conductor carries current between rectifier and cell circuit at Solvay Process Division of Allied Chemical Corp., Moundsville, W. Va.

ALCOA ALUMINUM BUS CONDUCTOR SAVES MONEY FOR SOLVAY PROCESS

Initial savings were in material costs. Aluminum is about 50 per cent lower than equivalent copper. There were savings in installation costs, too: aluminum bus is easier to handle and fabricate, and goes up faster with less labor.

This is the second aluminum bus conductor installation by Solvay Process. The performance and economy of the first led to this second installation.

Low material costs, low installation and maintenance costs, plus easy-to-make connections, are strong reasons to use Alcoa® Aluminum Bus Conductors. An Alcoa service engineer will be glad to give additional assistance in the design and construction of aluminum bus conductor installations.

Write for a copy of *Alcoa Aluminum Bus Conductor Handbook.* Aluminum Company of America, 2120-A Alcoa Building, Pittsburgh 19, Pa. A wide variety of sizes are available from Alcoa Distributors.

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EDITED BY R. F. FREMED

Starting Next Week, If You Earn Less Than $6,500/Yr.

You May Be Entitled to Overtime Pay

New overtime rules covering professional, executive and administrative employees take effect on Feb. 2nd.

LAST April Secretary of Labor James P. Mitchell proposed that the federal minimum salary levels for professional, administrative and executive employees be raised and he invited interested parties to submit their opinions on how much the hike should be and to whom it should apply.

It has taken the better part of a year to sift through the proposals, and next week the new salary requirements for the exemption of white-collar employees from overtime payments will go into operation. Effective date is Feb. 2, 1959.

Formal announcement of these new wage-and-hour regulations, written in hard-to-understand legalistic language, appears in the Nov. 18, 1958 issue of *The Federal Register*. In simpler terms, here's how these new regulations will affect you.

It's unlikely that any graduate engineer reading this is earning less than $95/week ($4,940/yr.) since starting salaries for engineering graduates are now well into the $5,000-6,000/yr. range. But just in case, here goes. If you earn less than $4,940/yr. you cannot be exempted from overtime pay no matter what your job responsibilities nor whatever your title may be. Your employer must pay you at the rate of time-and-one-half after you work more than 40 hours in any week. (This assumes, of course, that your employer is engaged in interstate commerce. Most employers of engineers are.)

At the other end of the scale, if you earn more than $125/week ($6,500/yr.) it will be hard to get a Dept. of Labor investigator to consider your claim for overtime payments. He will probably use the so-called "shortened duty test" and assume that at that salary level—if your primary duty consists of work either requiring advanced knowledge in a field of science or learning or requiring exercise of discretion and judgment — you probably meet all of the requirements of the exemption regulations.

It is in the grey area between $4,940-$6,500/yr. that most claims for overtime pay will arise. If your salary falls into this bracket, you may very well be entitled to overtime pay and it would be to your advantage to have the Wage and Hours Div. of the U. S. Dept. of Labor analyze the duties of your position to decide whether you are exempt or non-exempt.

Likewise, if you have chemical engineers working under your direction and their salaries fall into this new range, you ought to familiarize yourself with the official definition of a professional chemical engineer.

For further details, see our previous article on this subject (*Chem. Eng.*, Dec. 1, 1958, p. 127) or contact your nearest office of the U. S. Dept. of Labor, Wage and Hours Div.

Our Economic Survival Depends on You

Efficient use of capital funds, key to survival in the years ahead, lies in the hands of engineers.

GATHERED in Cincinnati last month amidst the futuristic decor of the Netherland-Hilton's Pavillion Caprice, banqueting chemical engineers sat enthralled as Monsanto's Charles Allen Thomas heaped praises upon them.

However, woven among the recognition of past accomplishments were serious challenges for the future.

"I recognize that you are versatile persons whose skills are used in all branches of the chemical industry. Individuals trained in chemical engineering contribute to all the functional activities of our industry: research, sales, manufacturing, administration and, of course, engineering.

"I wish to address myself to those chemical engineers in our industry who are engaged in the all-important activity of engineering the new plants and plant improvements — that is, those men who are responsible for designing capital additions. They have a unique and important control of capital expenditures, inasmuch as their decisions as to design determine the money to be invested.

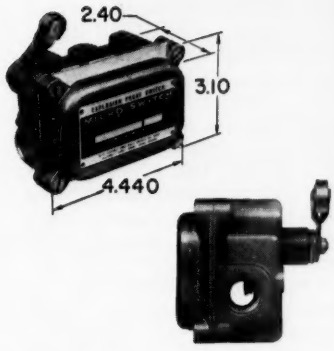
"In a capitalistic economy of free competitive enterprise, the efficient utilization of capital in large measure is the difference between success and failure.

"In the chemical industry, the responsibility for this efficient utilization lies in the hands of chemical engineers, and the next ten years will make this responsibility an important one indeed."

Thomas then went on to credit the chemical engineer for much of the past success of the chem-

MICRO SWITCH Precision Switches

Compact high capacity UL listed explosion-proof switches



There is a wide variety of explosion-proof switches in the MICRO SWITCH precision switch line to help you boost productivity of equipment

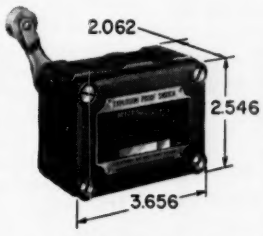
Here are a few examples of the many variations in mechanical and electrical characteristics, housings and actuators which are available in MICRO SWITCH explosion-proof switches. All feature rugged construction in sturdy housings, with a choice of mounting positions. Information on these precision switches is available from the MICRO SWITCH branch office nearest you.

Listed by Underwriters' Laboratories for use in hazardous atmospheres Class 1, Group C and D; Class 2, Groups E, F and G.

NEW

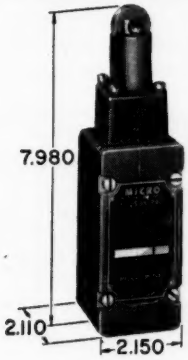
"EX1" SERIES

Series "EX1" switches have a conduit opening at both ends of the housing. This permits through wiring, which saves costs and space and improves appearance of the installation. Series "EX1" switches are available with four types of basic switches, with variations in electrical ratings, size of conduit openings and circuit arrangements. The switch illustrated has two ½-inch 14NPT conduit openings; capacity is 15 amps. 125, 250, 460 vac; ½ amp. 125 vdc; ¼ amp. 250 vdc. Contact arrangement is SPDT. Request Catalog 83.



"EX" SERIES, "AR" TYPE

Series "EX" switches have single conduit openings. They are available in a complete selection of actuators. There are 27 variations of the "AR" type alone, representing a wide choice of operating characteristics, electrical capacities and contact arrangements. This "EX" series switch is designed for cam or slide operation. Actuator is operated by clock-wise rotation, and it is adjustable through 360°. The roller is of non-sparking silicon bronze. Send for Catalog 83.



"ML-E1" SERIES

The "ML-E1" series of explosion-proof limit switches meets a wide range of requirements. For example, there are two-circuit double-throw double-break switches with a rating of 10 amps. 120, 240, 480 or 600 vac; 0.8 amp. 115 vdc; 0.4 amp. 230 vdc. The roller plunger actuator is for cam or slide operation. Sealed head can be rotated 90°. Wide choice of other actuators. Send for Catalog 84.

"ML-E1" SERIES

This series "ML-E1" switch has a roller lever actuator which can be positively locked at intervals of approximately 0.4° (870 positions). The actuator can also be adjusted to actuate the switch in the clockwise direction only, the counter-clockwise direction only, or in both directions. The head assembly can be faced in any of four directions and the roller arm may be reversed on the head. Send for Catalog 84.

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MICRO SWITCH PRECISION SWITCHES

ical industry. "Through the skillful design of industrial units, he has made it possible for the discoveries of the scientist to evolve from laboratory curiosities into commercial products that have had favor in the market places. He has provided work for an increasing number of people at a steadily increasing rate of compensation.

"Where deficiences in the knowledge necessary for him to carry out his job have become apparent, he has turned to research and developed this knowledge, using methods that enabled him to adapt it readily to design."

So much for the past—what about the future?

"One thing seems obvious. The chemical industry in the next decade will be characterized by the greatest competition our industry has ever known. There will be an increasing demand for chemicals and plastics, but *satisfactory profits* will only be had by the low-cost producer.

" 'Well,' you may say, 'this man is certainly pessimistic about the future.' But in fact I am *not*. I merely wish to emphasize how important the chemical engineer will be in the next ten years—for only by the brilliant work of chemists and engineers can we get out of this squeeze."

Thomas predicts that some plants built in the heyday of the last few years will have to be redesigned or they'll be forced to go out of business.

"Tomorrow's plants will have more pieces of equipment designed by clever engineers to do a specific job well under a particular set of conditions, rather than using the so-called standard design units. Chemical firms that continue to show a profit on their operations will do so largely because of the brains of their engineers to give them the lowest costs. Economic survival will depend more and more on ingenious engineering."

To sum up, Thomas used these words: "The chemical engineer of the future will make more use of science than he has in the past. As he does he will receive even greater recognition. He will play an important part in the long-range planning of his organization."

How Do You Identify a Professional?

What kind of badge should we hang on professional engineers so that the world will know them as such?

CONTROVERSY erupted at the Professional Development panel discussion in Cincinnati last month. Mechanical engineer C. Y. Thomas, vice-president of Spencer Chemical Co., accused chemical engineers in general—and AIChE in particular—of sticking their heads in the sand when it comes to the licensing of engineers.

What Mr. Thomas doesn't seem to understand is why we as chemical engineers refuse to agree that the only way to decide whether or not a man is a professional person is to look on the wall of his office to see if a license from the State is on display. Mr. Thomas feels that a license is the first mark of professional identification.

It took most of the afternoon for the audience to explain the attitude of chemical engineers to Mr. Thomas. He left unconvinced, even after outgoing AIChE President George Holbrook took the microphone to speak for the Institute itself in clarifying Council's official policy statement.

AIChE believes that professional responsibility for engineering work is a personal responsibility and that personal responsibility should be recognized by all laws relating to the registration of the professional engineer. Also, the Council of the Institute has gone on record to the effect that it is opposed to legislation that requires the compulsory licensing of engineers who practice in the nonpublic field.

What's behind this attitude? Basically, we chemical engineers have a feeling that registration as a professional engineer and the acquisition of a fancy document from the State is only one of several ways to identify a professional person.

It is certainly not the only way. In fact, there are many who feel that licensure is far from being the most important or significant way of identifying a professional engineer. We need look no further than the recently revised ECPD brochure on the first five years of professional development to understand the other aspects of professional identity. ECPD advises, "To ensure your proper professional identification:

- Be an active participant in the affairs of the professional society which represents your major field of engineering activity.
- Identify yourself as an exemplary professional man through your personal conduct."

ECPD also includes the advice that you qualify for full professional registration in your State. However, this suggestion is given second-place in the list of several professional identification marks.

The controversy is unsettled and the Professional Development committee of AIChE will be working on this problem during the coming year.

'CHEM. ENGINEER

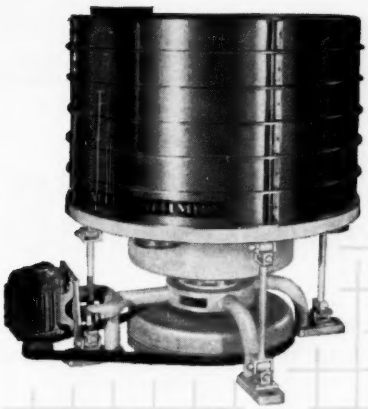
. . . *Gets State Dept. Nod*

The Dept. of State has re-established its overseas Science Officer Program with appointment of men to serve in the U. S. embassies in London, Paris, Rome, Bonn, Stockholm and Tokyo.

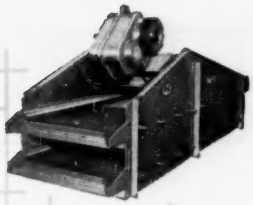
Among the appointees is Dr. Edward L. Piret, professor of chemical engineering at the University of Minnesota. He will be chief science officer in our Paris embassy.

A recipient of a Fulbright research professorship, Piret taught at the University of Nancy and the University of Paris.

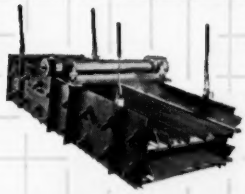
Before the end of next year, the U. S. expects to fill similar posts in the U. S. S. R., India and South America. Eventually, State Dept. expects to have both a science officer and a deputy in each post. Their mission will be to advise the ambassadors on the interaction of science and U. S. foreign policy.



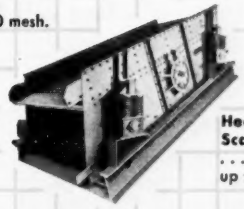
Stainless Steel Gyratory Screen
. . . for size classifications 2 to 325 mesh.



Horizontal Screens
. . for separations up to 2½ inches.



Small Inclined Screens
. . . for separations 1½ inches to 40 mesh.



Heavy Duty Scalping Screens
. . . screen apertures up to 12 inches.

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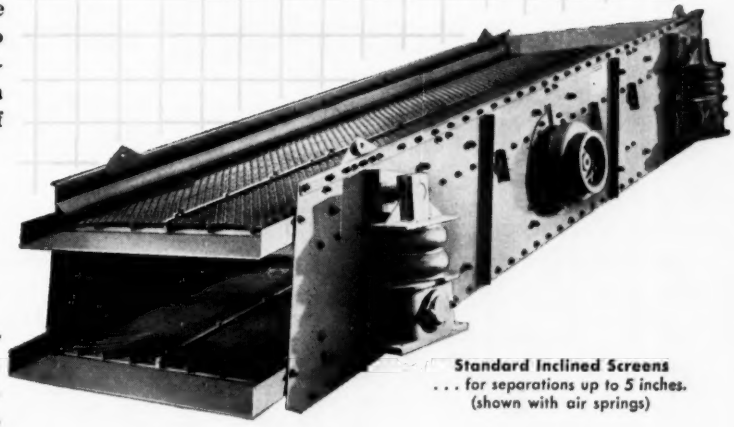


Standard Inclined Screens
. . . for separations up to 5 inches.
(shown with air springs)

ALLIS-CHALMERS

A-5583

At new nickel extraction plant . . .

Novel Designs Tame Tough Corrosives

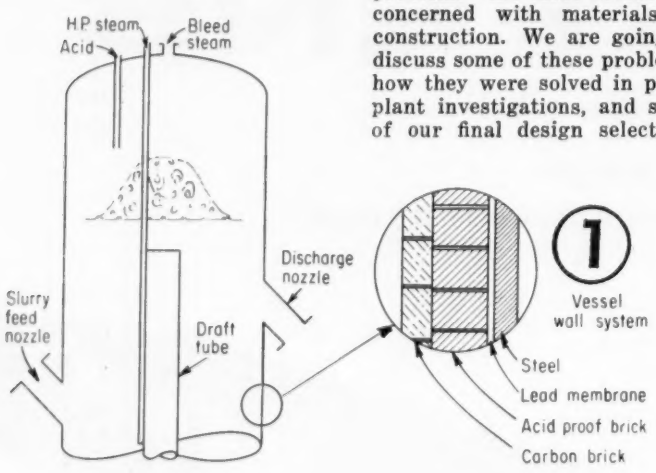
Severe processing conditions at Freeport Sulfur's Moa Bay nickel plant call for ingenious applications of materials of construction.

C. S. Simons, Chief Process Engineer, Cuban American Nickel Co., New Orleans, La.

1. Novel Lining Design

Design of Freeport Sulfur's 50-million lb./yr. nickel plant is about completed. The Moa Bay, Cuba, installation should go onstream during the summer of this year.

But the transition from bench-scale to commercial unit has been fraught with many problems—the most severe are concerned with materials of construction. We are going to discuss some of these problems, how they were solved in pilot-plant investigations, and some of our final design selections for the full-scale installation.

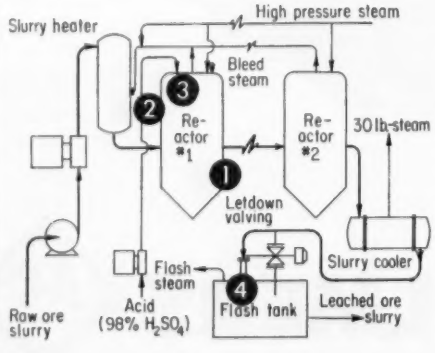


Key operation in the Moa Bay design is the leaching step (*see box below*). Here heated, thickened ore pulp contacts 98% sulfuric acid in leaching reactors. Agitation is by high-pressure steam injection. The ore slurry (35% solids) reacts very rapidly with H_2SO_4—residual acid seldom exceeds 3%. Temperature is 400-500 F., pressure above 500 psi.

▶**Material Composite**—Nickel alloys do not survive in this situation. Titanium stands up, but we consider it too expensive for reactor construction. Our solution to the problem is shown in Fig. 1—a lead-lined steel, acidproof brick, carbon-brick system.

This design looks fairly obvious, but it represents a great amount of testing and trial-and-error.

Some general observations

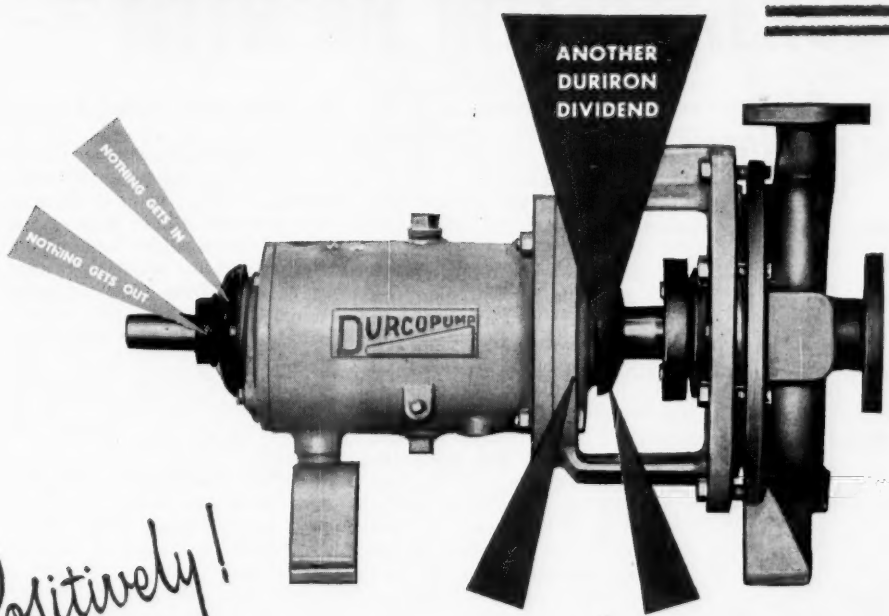


Design Calls for Acid Leaching of Ni Ore at Moa Bay.

Focal point of Freeport Sulfur's Moa Bay, Cuba, nickel operation will be the leaching system. Here thickened ore pulp (35% solids) will be preheated with recovered low-pressure steam to 160-180 F., then pumped to leaching reactors. Design calls for injecting high-pressure steam for final heating and agitation, then adding 98% H_2SO_4. Leaching will be carried out at 400-500 F., 500 psi. Further processing involves neutralizing the sulfate liquor containing nickel and cobalt, then precipitating the two metals with hydrogen sulfide. Practically all nickel and cobalt in the ore can be extracted, most of the iron rejected. The concentrate will go to Port Nickel, about 20 mi. south of New Orleans, for purification to the individual metals.

Note that this process differs from the ammonia system at Nicaro, Cuba. Nicaro ore is high in magnesium, while Moa Bay material has a low magnesium content and is high in iron. This dictated the more economical acid process.

A GREAT NEW IDEA
BEARING SEALS of TEFLON®



Positively!

NOTHING CAN GET OUT / NOTHING CAN GET IN!

A brand new idea in bearing seals is another Durco first. This amazingly simple device is leakproof and foolproof. Bearing life will no longer be shortened by splashed or spilled acids, and lubricant is positively sealed in.

These new bearing seals are just another one of the extras Durco gives you as standard. Large, solid, rugged shafts; heavy duty, long-life bearings; complete interchangeability with minimum parts inventory; these are standard with Series H-2 Durcopumps. They're extras on other chemical pumps; extras that you pay extra for. Series H Durcopumps give you premium quality and premium performance without the sting of premium price.

Teflon is the registered trade-mark of E. I. duPont de Nemours & Co. for its tetrafluoroethylene resin.

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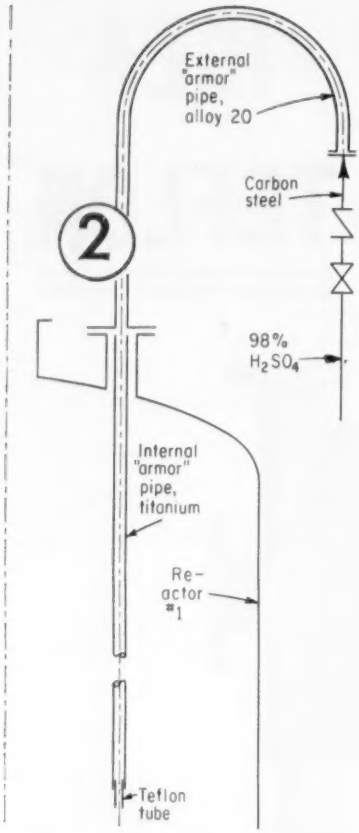
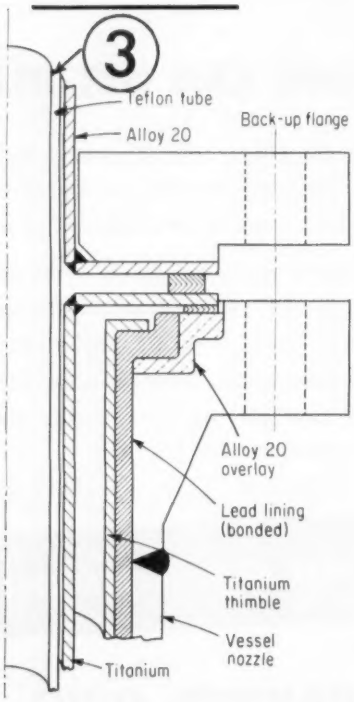
CORROSION RESISTING ALLOYS & EQUIPMENT

THIS NEW FEATURE AT NO EXTRA COST

The mark of dependability in tough chemical service . . . everywhere

THE DURIRON COMPANY, INC., DAYTON, OHIO





developed from this design should be of interest.

Bare lead linings—homogeneously bonded to the shell—are desirable from an economic standpoint. But we decided against bare lead because it is vulnerable to mechanical damage. It tends to crack with cyclic heating and cooling. This cracking doesn't occur when the lead is behind brick.

It is difficult to get a good lead bonding job for service at 400-500 F. After a few heating-cooling cycles, unbonded areas develop blisters. Particular care is needed over heavy sections such as flanges.

▶ **Bonding Tricks**—From our experience with bonding we now know: (1) Bonding must be done by hand on a clean steel surface. This means grinding the steel with a Carborundum wheel and immediate tinning before the ground surface can oxidize. We dislike sand-blasting because of sand grain inclusions. Acid washing must not be used. (2) Any good tin-lead solder can be used for tinning, and the steel must be hot enough so it is thoroughly wet by the solder. Excess solder must be removed with at least two separate wipes with clean rags. (3) Lead should be chemical grade.

With regard to brick, we found all acidproof brick spalls in our system. Carbon brick does not spall, but it is not a very good thermal insulator.

So we selected acid brick for internal thermal insulation, carbon brick to protect the acid brick.

Using this system, the steel outside surface is at 225 F., with an internal temperature in the reactor of 475 F.

Even more troublesome than the correct brick was choice of a suitable mortar. None of the silicate mortars stood up, probably because the system is not acid enough to get a good cure. Furane materials also failed due to the oxidizing conditions present. Epoxy resins are excellent but difficult to apply. So the final cement was a furfuryl alcohol based material for the acid brick course; National Carbon C-6 cement for the carbon brick.

C. S. SIMONS *has been closely connected with the Moa Bay process for more than 7 years, starting with the pilot-plant investigations. Mr. Simons is a chemical engineering graduate from Rice Institute. He is the author of a number of patents based on the nickel extraction process.*

2. Continuous Teflon Liner...

The Fig. 2 shows a solution to another serious problem—getting acid continuously into the reactor. Glass proved too fragile, even with "armor."

Occasionally we had to shut off acid flow momentarily. When this happened, acid drained from the line, and steam entered the tube. This diluted and heated the acid—the adaptor and metal line adjacent to it was rapidly attacked.

▶ **Teflon Unaffected**—The successful design shown in Fig. 2 uses a continuous Teflon liner. Externally a "hairpin" of Sch. 40 Carpenter alloy 20 pipe is used from the vessel flange. Teflon is subject only to the pressure of the fluid head loss within it. When acid flow is shut off, the line may drain up to the high point and steam can reflux. This doesn't affect the Teflon, and the acid connection cannot get hot nor can dilute acid reach it.

3. ...Solves Injection Problem

The Fig. 3 shows the method of going through the vessel nozzle with the acid injection line. Alloy 20 external pipe ends in a 3/16-in. plate flange welded to the pipe. The titanium "armor" pipe internal to the reactor is identical to this at its upper end. These are flanged together using a carbon steel blind, machined to fit, as a back-up flange, and seal is obtained with a spiral-wound gasket.

This drawing also shows the method employed to protect the lead lining in the small vessel nozzles. Nozzle design for these

vessels required close attention because of the severe service.

The nozzle flange is machined out and an alloy 20 overlay applied. The alloy 20 forms a bearing surface for the seal gasket. The overlay is remachined to the O.D. of the seal gasket, and upset so the lead lining can be brought over the flange. Finally a titanium thimble, with a top flange as support, is slipped in. This serves to protect the lead from mechanical damage, and give it support against creep.

4. Throttle With Ceramic

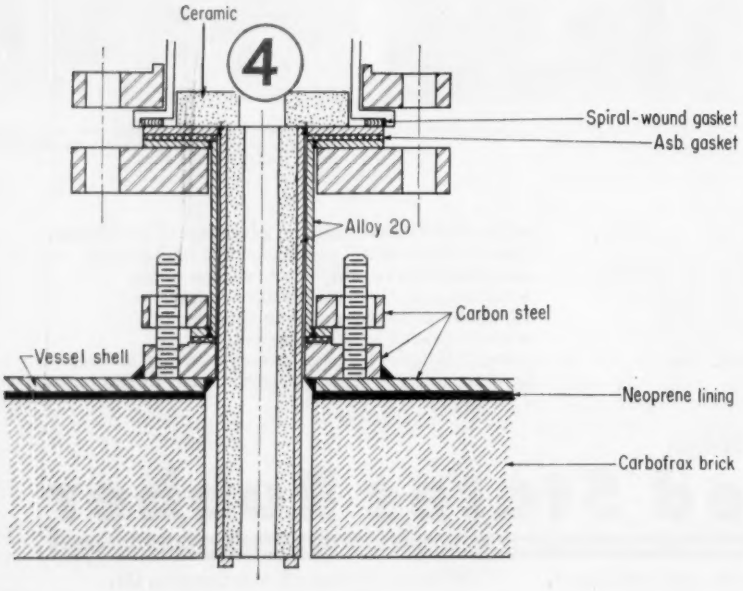
The final point to be covered is the problem of getting the leached material out of the system and back to atmospheric pressure, via flash tanks.

The material, after the acid reaction, is about 30-35% solids slurry of very fine iron oxide (predominantly) at 500-550 psi. And it is, even after heat recovery, still above the atmospheric boiling point. This means it will flash. And a flashing, acid slurry taking a 500 lb. pressure drop is a very tough throttling problem.

The final solution, shown in part in Fig. 4, represents the end of a long development program. It was determined quite early in the work that conventional valving had no chance of success. Both Calera Mining Co. at Garfield, Utah, and National Lead Co. at Fredericktown, Mo., have similar problems. While the final solution arrived at differs from theirs, they were very helpful in pointing out lines of approach that undoubtedly shortened our period of development.

Nothing will stand the abrasion of these slurries at high velocities for any really long time. Their action is similar to grinding with jeweler's rouge suspended in acid. This fact meant that there was no real chance of throttling the flow to an exact rate. So development was aimed at finding a system where the valves could be operated off-on. In this way, wear on the trim is confined to the instants of opening and closing, and life of the trim becomes a function of the number of cycles.

▶ **For Erosives**—Ceramic chokes have been in use in oil field production for a good while now. It was decided, since ceramic is one of the most satisfactory trim materials available, that control should be built around standard oil field chokes, or Refrax chokes made to the same dimensions. The finally accepted design, shown in Fig. 4, should give good service.



The scheme provides two chokes in parallel; one, sized to handle about 90% of normal total flow, will form the terminus of the discharge pipe from the slurry cooler-boilers; the other, sized to handle about 15% of normal total flow, will be mounted below an off-on control valve actuated by surge level in the flash tank.

The controlled flow bypass line branches off the main line 15 in. above the pad flanges on the flash tanks. The main line is flanged upstream of the bypass. This makes a compact assembly which can be easily removed by breaking out three flanges—the two pads and the main line. A different unit is then installed and the old unit may be taken to the shop for inspection and replacement.

▶ **How to Install**—Note the choke section consists of two chokes cemented in a section of pipe. Back-up plates are used to give added assurance of choke retention. These support barrels may be used again to assemble replacement units. A necessary part of the assembly is the ceramic disk with a bore somewhat larger than the choke bore; this prevents erosion of the support plate due to entry turbulence.

It was found that, when metal temperature was kept below 250 F., a number of alloys give satisfactory service in the leached slurry. The metal selected for choke holders and control valve body is alloy 20; this was found by extensive testing to be twice as resistant to the system as Type 316.

Condensed from a paper given by the author at a recent South Central Regional meeting of the National Association of Corrosion Engineers.

New Coating Prevents Molybdenum Oxidation

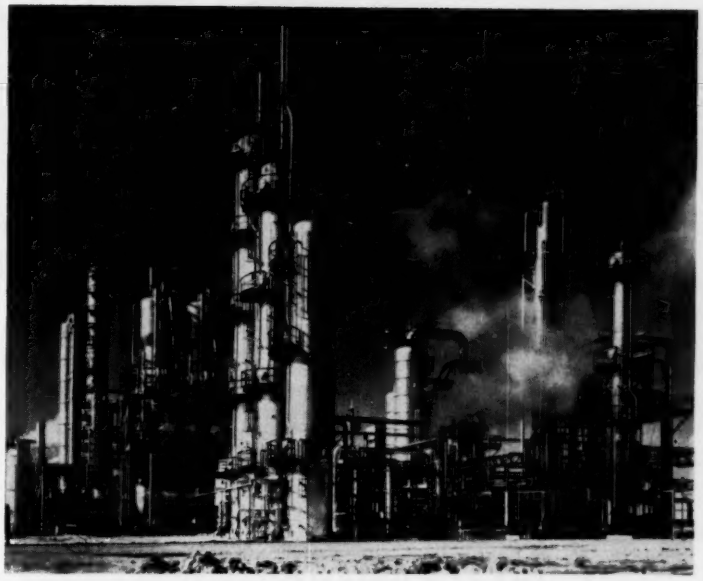
A new coating, developed by the National Bureau of Standards, may lick the old bugaboo of molybdenum oxidation.

The NBS coating is a composite of nickel over chromium. This is applied by electrodeposition. NBS claims their material has prevented molybdenum oxidation for over 1,000 hr. at 980 C., over 300 hr. at 1,100 C.

FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES



More Ethylene Oxide Via the Shell Process

Calcasieu Chemical's ethylene oxide-glycol plant at Lake Charles, La., is on stream producing 60 million lb./yr. oxide or 8 million gal./yr. glycol. Plant, using Shell Development's process for oxygen-oxidation of ethylene, was engineered and built by the Lummus Co.

American Gilsonite is expanding, from 700 to 850 tons/day, the capacity of its Gilsonite, Colo., refinery producing gasoline, fuel oil, calcined coke and other products from gilsonite. Cost of expansion, including additional reactor and compressor capacity for the catalytic reformer, is set at $450,000.

Scientific Design Co. has started up what is billed as "first commercial plant using a liquid-phase air-oxidation process" for making terephthalic acid for Mitsui Petrochemical Industries in Japan. Unit is part of a $30-million petrochemical project including ethylene oxide-glycol, cumene and para-xylene plants—all engineered by Scientific Design.

Reichhold Chemicals has expanded its Ballardvale, Mass., plant to manufacture 10 million lb./yr. acrylic emulsions, including a new line of products for the surface coating and leather finishing industries.

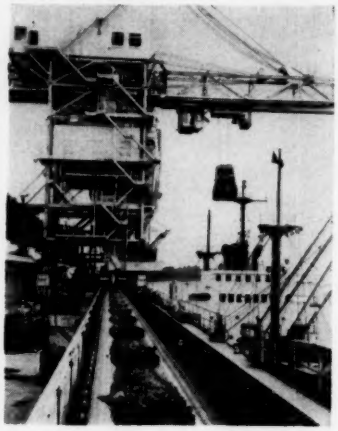
Kermac Nuclear Fuels Corp. has placed on stream the nation's largest uranium ore mill—rated at 3,630 tons/day ore. Mill, using acid-leach circuit, is located near Grants, N. M., and cost $18 million.

Du Pont is reportedly planning to build a new synthetic fiber plant in Holland, south of Rotterdam. Du Pont currently has a new lacquer plant under way; projects are being set up in connection with the

FIRMS . . .

European Common Market plan.

Alcoa is starting operations at its new Point Comfort, Tex., alumina plant February 1. Ultimate cost of this plant, called Alcoa's largest alumina refining unit, will be in excess of $45 million and it will employ more than 600 workers.



Ormet Corp. is the principal user of a new $15-million publicly-owned marine terminal on the Mississippi River 30 mi. below Baton Rouge, adjacent to Ormet's alumina plant. Above, bauxite is unloaded from a ship and transported by belt conveyor to the alumina plant.

Linde has construction under way on its new industrial gas plant in Pittsburg, Calif., with completion scheduled for early 1960. Design capacity is 300 tons/day liquid oxygen and nitrogen.

Lakeview Mining Co.'s new $3-million uranium ore processing mill is in operation at Lakeview, Ore. Daily capacity is 210 tons ore.

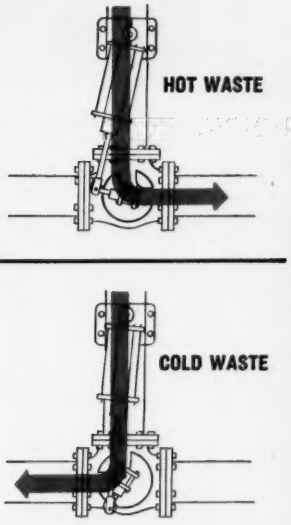
Tube-Kote has started construction on a new $250,000 pipe coating plant near Midland, Tex. Completion is slated for March 1959.

Reichhold Chemicals (Canada) is erecting a "sizeable" phenol plant and formaldehyde unit at the company's Port Moody,

How would you solve this problem?

Problem: Waste from a process unit varied in temperature with the process cycle. How would you control the waste flow to utilize hot waste and cold waste in heat exchangers in other parts of the plant?

Solution: Rockwell-Nordstrom 3-way Multiport valves (see below) were equipped with thermostatically controlled air cylinder actuators. As the temperature of the waste in the valve inlet line changes, the thermostat "tells" the cylinder to move the valve plug and automatically shunt the hot waste into one inlet line or the cooled waste into the other outlet line. *One valve does the job of at least three!*



Rockwell-Nordstrom Multiport valves are used in the process industries where 3-way and 4-way flow control is needed through one valve. They greatly simplify flow control and reduce cost by eliminating unnecessary piping and valves.

Rockwell-Nordstrom is the world's most complete line of lubricated plug valves—both Multiport and Straightway. Available in semi-steel, steel, stainless, Monel, Bronze and other corrosion-resisting alloys in sizes from ½" to 30" to meet every process valve need. For details, write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

ROCKWELL-Nordstrom VALVES

it's **ROCKWELL**

MANUFACTURING COMPANY

Send Coupon For Free Literature

Rockwell Manufacturing Company
Rockwell-Nordstrom Valve Division
Department CE Pittsburgh 8, Pa.

☐ Please send me complete information on Rockwell-Nordstrom valves for process, industrial and manufacturing flow control.

☐ Please send me the name of your nearest distributor . . . ask him (to) (not to) call immediately.

Name_____ Title_____

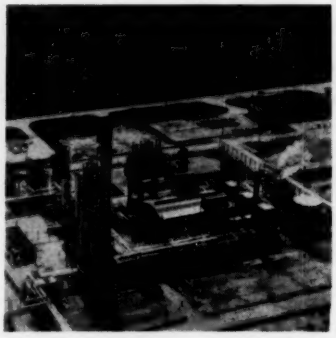
Firm_____

Street_____

City_____ Zone_____ State_____

FIRMS . . .

B. C., plant, and is building an additional phthalic anhydride unit at St. Terese, Que. Output of all the new units will go into captive uses.



Petroleum Chemicals' new 200-million-lb./yr. ethylene plant at Lake Charles, La., recently came on stream using a "new ethylene separation process" developed by the Lummus Co. Part of new plant's output feeds Calcasieu Chemical's adjacent ethylene oxide and glycol plant.

Stone & Webster Engineering Ltd. (London) will design and build a third ethylene plant for British Hydrocarbon Chemicals' Grangemouth, Scotland, complex. New unit will be "considerably larger" than any other unit in Europe.

SunOlin Chemical Co. is building a $77,000 office building in Claymont, Del. Building will eventually house administrative offices for SunOlin's new urea plant at Claymont.

Oronite Chemicals Co. and Nippon Petrochemicals are drawing up plans for a joint company that would build and operate an 11,000 ton/yr. alkyl benzene plant between Tokyo and Yokohama. Tentative plans are being submitted to the Japanese Government.

UBS Chemical Corp. has started operations at its new polymer emulsions plant in Lemont, Ill. Plant, designed and built by Badger Mfg. Co., is similar to the original unit built in 1955 by Badger for UBS in Cambridge, Mass.

CALENDAR

Society of Plastic Engineers, annual technical conference, Commodore Hotel.
Jan. 27-30 New York, N. Y.

First International Symposium on Nuclear Fuel Elements, jointly sponsored by Columbia University and Sylvania-Corning Nuclear Corp., Columbia University.
Jan. 28-29 New York, N. Y.

American Physical Society, annual meeting, New Yorker Hotel.
Jan. 28-31 New York, N. Y.

Society of Plastics Industry, Reinforced Plastics Division, annual technical and management conference, Edgewater Beach Hotel.
Feb. 3-5 Chicago, Ill.

American Institute of Mining, Metallurgical and Petroleum Engineers, annual meeting, St. Francis, Sheraton-Palace and Sir Francis Drake Hotels.
Feb. 15-19 San Francisco, Calif.

Lehigh Valley Chemical Engineers Club, Topic: Radioactive Tracers in Process Control, The Chapman Restaurant.
Feb. 16 Bethlehem, Pa.

Chemical Market Research Assn., meeting topic: Chemicals for the Textile Industry, Dinkler Plaza Hotel.
Feb. 18-19 Atlanta, Ga.

Chemical Institute of Canada, Protective Coatings Division, annual conference.*
Feb. 19 Toronto, Ont.

Chemical Institute of Canada, Protective Coatings Division, annual conference. *(duplicate program)
Feb. 20 Montreal, Que.

Technical Assn. of the Pulp and Paper Industry, 44th annual meeting, Commodore Hotel.
Feb. 23-26 New York, N. Y.

National Assn. of Corrosion Engineers, annual meeting and exhibition, Sherman Hotel.
March 16-20 Chicago, Ill.

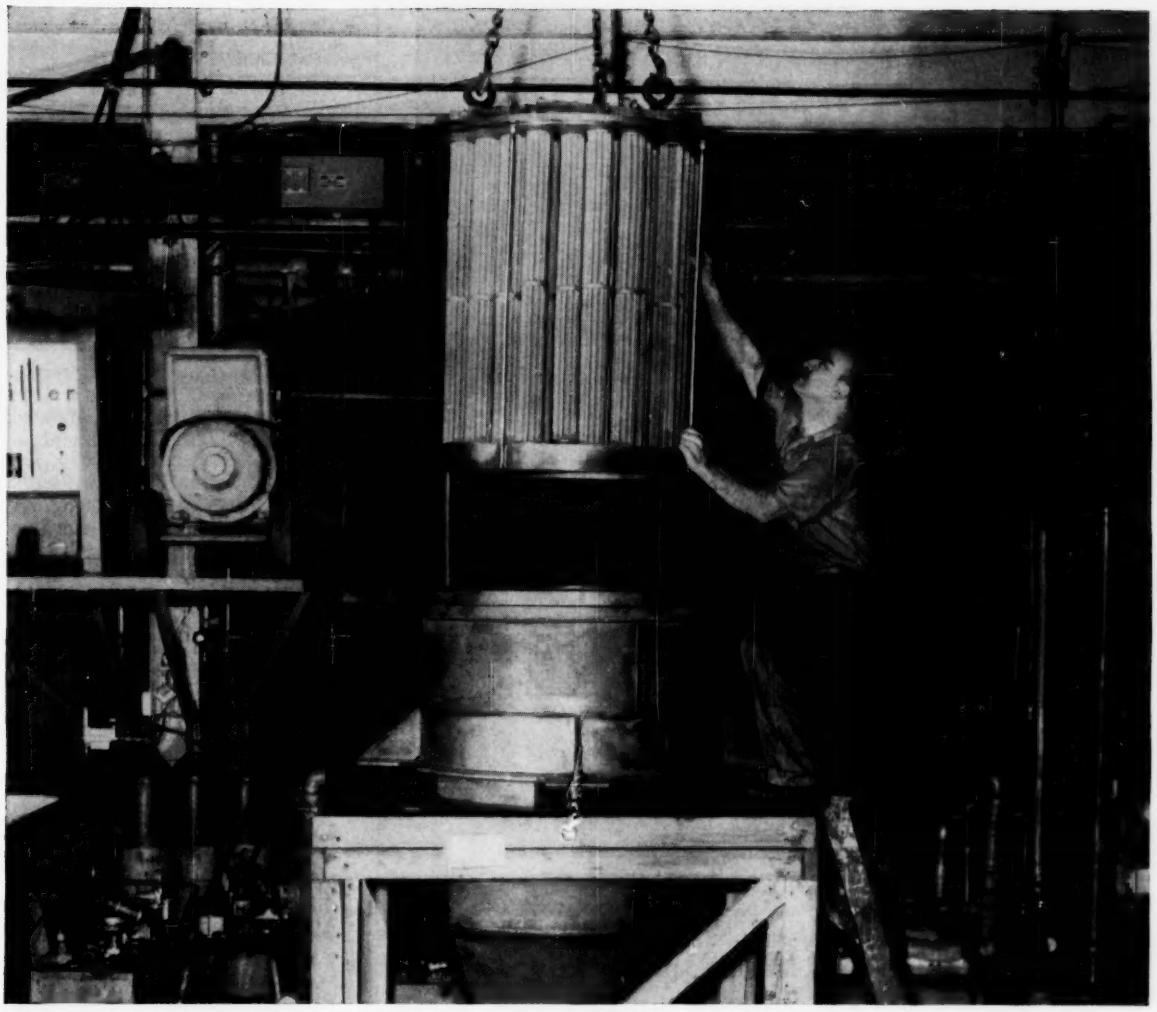
American Society for Metals, 11th Western Metals Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel.
March 16-20 Los Angeles, Calif.

American Institute of Mining, Metallurgical and Petroleum Engineers, Technical Conference: Stress Corrosion, Mellon Institute.
April 2-3 Pittsburgh, Pa.

American Chemical Society, annual national meeting.
April 5-10 Boston, Mass.

Nuclear Congress, coordinated by the Engineers Joint Council, Public Auditorium.
April 5-10 Cleveland, Ohio

American Institute of Mining, Metallurgical and Petroleum Engineers, 42nd national Open Hearth Steel Conference and Raw Material Conference, Jefferson Hotel.
April 6-8 St. Louis, Mo.



Built to withstand highly corrosive fluorine-containing gases, Monel nickel-copper alloy porous sintered filter elements are lowered into shell. Entire unit, including housing was constructed by Purolator Products, Inc., Rahway, N. J.

Filters most corrosive element known ...with porous sintered Monel

This filter reclaims solid particles from a gaseous stream containing fluorine – the world's most reactive element. It's made of porous sintered Monel* nickel-copper alloy, stands up in fluorine service much longer than filters of other materials. Housing and cover are Monel, too.

Porous metal filters of Monel and other Inco Nickel Alloys are proving invaluable wherever corrosion, cyclic shock, heat or radioactivity must be reckoned with. They're made with pore sizes from 50 down to 0.2 microns, ± 10%.

For high-temperature filtering . . . particularly above 1000°F, porous sintered Inconel* nickel-chromium alloy is used . . . for filtering such materials as molten sodium and potassium and removing catalyst particles from gaseous products of catalytic cracking units.

For low-temperature filtering . . . handling liquid helium, liquid oxygen. Here, porous Monel alloy and Nickel stand up where glass or cellulose fibers break up . . . retain useful properties even below minus 450°F.

In many areas of the expanding nuclear industry, Inco Nickel Alloys provide useful combinations of corrosion resistance, strength at both low and high temperatures, good thermal and electrical properties.

Our new booklet "Handling Fluorine and Fluorine Compounds with Inco Nickel Alloys" shows many industry-proven applications. Yours for the asking from Inco.

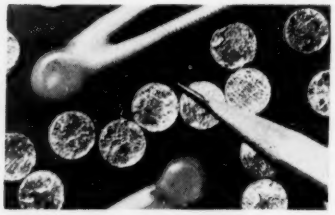
*Registered trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO NICKEL ALLOYS

NEW EQUIPMENT . . .

(*Continued from p.* 74)

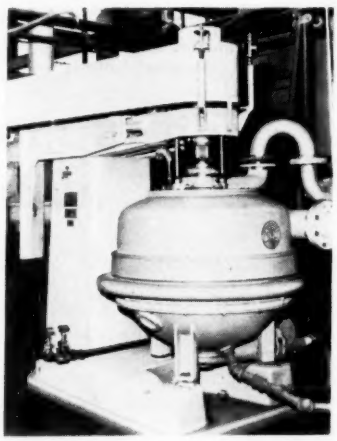


Thermistors

Have positive temperature coefficient of resistance.

Conventional thermistors have a temperature coefficient of resistance that is negative. However, a new thermistor family having a positive coefficient has just been announced. Resistance of these units increases sharply when a specified temperature is reached.

First application for the new series will be over-temperature protection of totally enclosed motors. Each aspirin-size thermistor embedded in a motor's winding will act, in effect, as an individual external relay that opens when the winding reaches critical temperature.—**Westinghouse Electric Corp., Pittsburgh, Pa.** **144A**



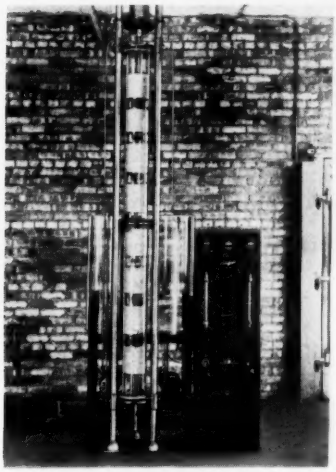
Centrifuge

Has increased capacity, higher efficiency.

An improved design of the Merco centrifuge that permits higher rotor speeds than formerly possible will handle up to 600 gpm. with substantial

reductions in power consumption. Known as the H-30, the unit is claimed to be applicable over a wide range of concentrations to clarification and thickening of slurries containing extremely fine solids.

Major difference between the H-30 and the standard Model 30 exists in redesign of the new machine's rotor to accommodate speeds up to 3,300 rpm. H-30 comes only with a 37-in. stainless steel rotor and either a bronze or stainless housing. **—Dorr-Oliver Inc., Stamford, Conn. 144B**



Solvent Extractor

Package for low-cost, low-capacity operations.

Preassembled units designed for liquid-liquid extractions on a pilot-plant or small-production scale are available in capacities of 20 cc./min. to 20 gpm. Each system is tailor-made to customer requirements, with a choice of either manual or automatic control instrumentation.

Known as Spiradynes, all models consist of an alternating series of mixing and clarifying sections enclosed within a gravity-type column. Impellers mounted on a single central shaft provide the necessary intimate phase contact in the mixing sections. Highly efficient coalescent packings promote phase disengagement in the clarifying sections. Number of

identifiable stages varies with application.—**Podbielniak, Inc., Chicago, Ill.** 145A

Slurry Sampler

Takes secondary cuts from primary samples.

Designed to operate either continuously or automatically upon signal, a new machine provides a refined method for gathering secondary samples of wet materials. Known as the Secondary Vezin Sampler, the unit takes 16 sample cuts in about 3 sec. to produce a composite sample representing 10% of a primary cut. By blinding off one to three of the four cutters, this percentage can be dropped to as low as 2½%.

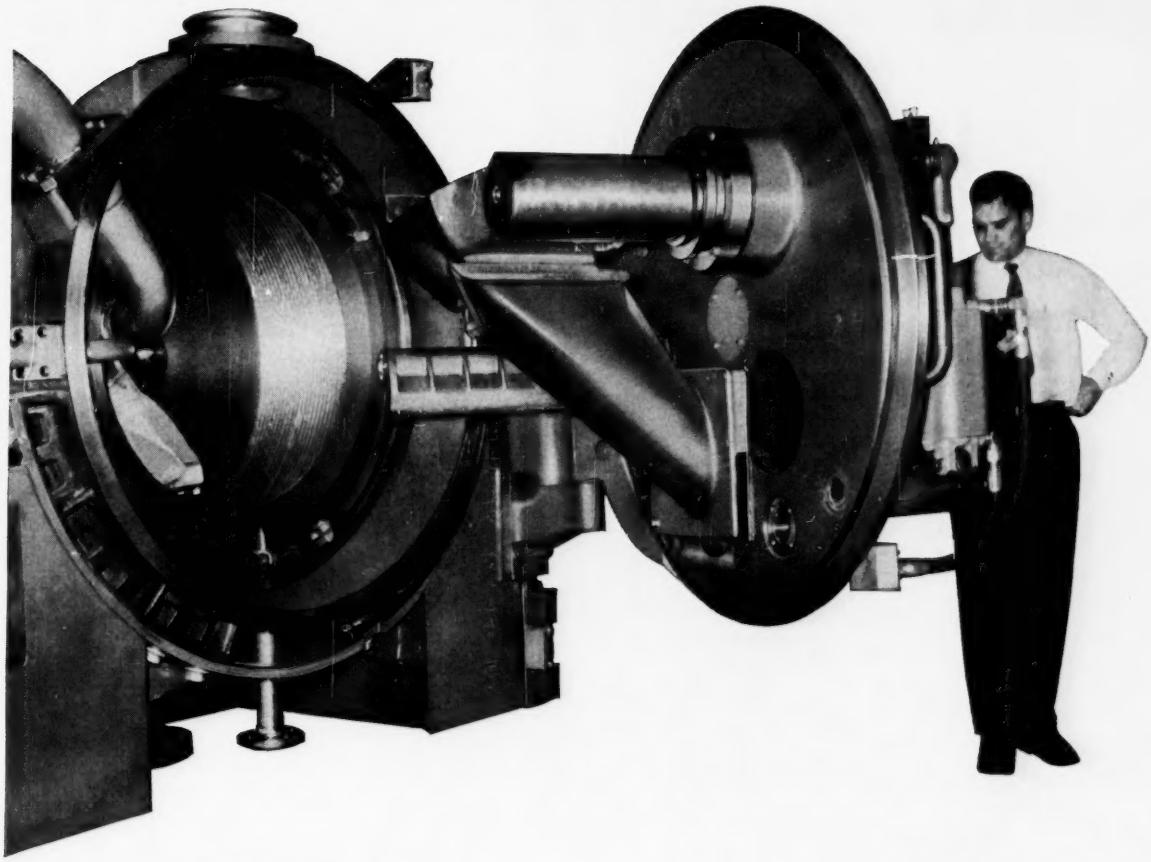
A standard 220/440-v. gear motor rotates the cutters at 44 rpm. Fob cost is less than $300. —**Denver Equipment Co., Denver, Colo.** 146A

Homogenizer

Delivers high-stability dispersions, emulsions.

Known as the #3 Jet-Mogenizer, a new addition to the manufacturer's line of homogenizers sets up countercurrent interparticle attrition effects on processed fluid masses. In addition to this attrition, the unit

a new dimension in crystal dehydration



CAPACITIES OF THE NEW SHARPLES C-41 SUPER-D-HYDRATOR ON REPRESENTATIVE SLURRIES.

AMMONIUM SULFATE —a relatively large free-draining inorganic crystal . . .
20-24 tons/hour

"CAUSTIC SALT" —a relatively small, slower draining crystal requiring high efficiency rinsing . . .
13-16 tons/hour

POLYPROPYLENE —typical of extremely fine, slow draining, low bulk density organic solids . . .
1.0-2.5 tons/hour

The C-41 Super-D-Hydrator is the largest of 3 high efficiency crystal drying centrifuges by Sharples (C-20;C-27;C-41) which are designed for both atmospheric and pressurized operation, and are available in various standard materials of construction.

Sharples engineers have incorporated many innovations in the design of the new C-41, learned in over 40 years experience in the chemical industry, and are further prepared to give special design consideration to each specific problem. May we consult with you regarding your separation problems?

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harnesses impact, turbulence and ultrasonic cavitation effects to continuously give more complete and faster homogenization at lower cost.

Output, which varies with viscosity and specific gravity of processed materials, is 250 to 400 gph. Jet-Mogenizers are self-cleaning.—**Buschman Products Inc., N. Y., N. Y.** **146B**

BRIEFS

Engine that operates on a normal steam-engine cycle acts as a power-producing reducing valve when installed between high-pressure natural gas pipelines and low-pressure process lines. Outputs range from 10 to 400 hp.—**Troy Engine & Machine Co., Troy, Pa.** **148A**

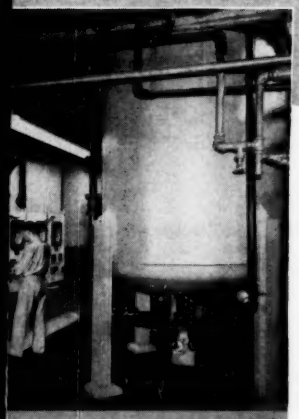
Orifice plate, which fits into place between head and tail pieces of pipe unions, converts the manufacturer's conventional unions into devices for measuring or controlling flow. For ¼- to 2-in. piping.—**Catawissa Valve & Fittings Co., Catawissa, Pa.** **148B**

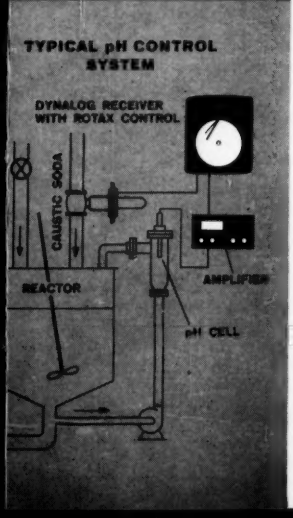
Diaphragm valves, designed for actuation by any three-way pilot valve, instrument control or process timer, feature neoprene-covered synthetic fabric diaphragms. Air actuation required runs from 20 to 60 psi.—**Valvair Corp., Akron, Ohio** **148C**

Rubber-lined pump designed for heads up to 140 ft. and capacities to 8,000 gpm. has been added to the manufacturer's line of abrasive-handling machines.—**Allis-Chalmers Mfg. Co., Milwaukee, Wis.** **148D**

Volumetric pump for small flow rates has a continuously adjustable pumping rate over a 50:1 range. Entire unit mounts directly on ½-in. piping.—**Lester-McKinney, Inc., Chester, Pa.** **148E**

V-belt drive line uses belts that are only ⅜-in. wide, and sheaves that are greatly reduced in both width and out-





at Sika Chemical—

REACTORS CONTROLLED WITHIN 0.1 pH

by Foxboro **DYNALOG*** Recorder-Controllers

At Sika Chemical Corp., Passaic, N. J., control of pH in reactors is of vital concern in manufacturing "Plastimet," Sika's widely-used concrete densifying additive.

Sika finds Foxboro Dynalog Recorder-Controllers perfect for the job. Dynalog's smooth variable air capacitor (which replaces troublesome step-by-step slidewires) responds instantly to the smallest change in pH value. A Rotax on-off control unit then initiates addition of enough caustic soda to return reactor pH to set point.

Sika reports maintenance on their Dynalogs has been almost nil. One tube replaced in three years. No lubrication ...no cleaning...no dry cells to standardize or replace. "In fact," says process engineer Gordon Morrison, "we're so confident of Dynalog's performance that our reactors run right through the night—unattended."

Dynalog Electronic Recorders—Controllers—Indicators deliver accurate, sensitive, measurement not only of pH, but of dozens of other variables as well. Get full details by writing for Bulletin 20-10. **The Foxboro Company, 361 Neponset Ave., Foxboro, Mass.**

Reg. U.S. Pat. Off.

FOXBORO
REG. U.S. PAT. OFF.

DYNALOG ELECTRONIC INSTRUMENTS

side diameter. Net result is a reduction in cost and space requirements. — **Dodge Mfg. Corp., Mishawaka, Ill. 148F**

Worm-gear speed reducer line with reduction ratios ranging from 70:1 to 5:1 is available for applications requiring continuous, demanding service. Aluminum fans cool the easy-to-mount cast-iron casings. — **DeLaval Steam Turbine Co., Trenton, N. J. 150A**

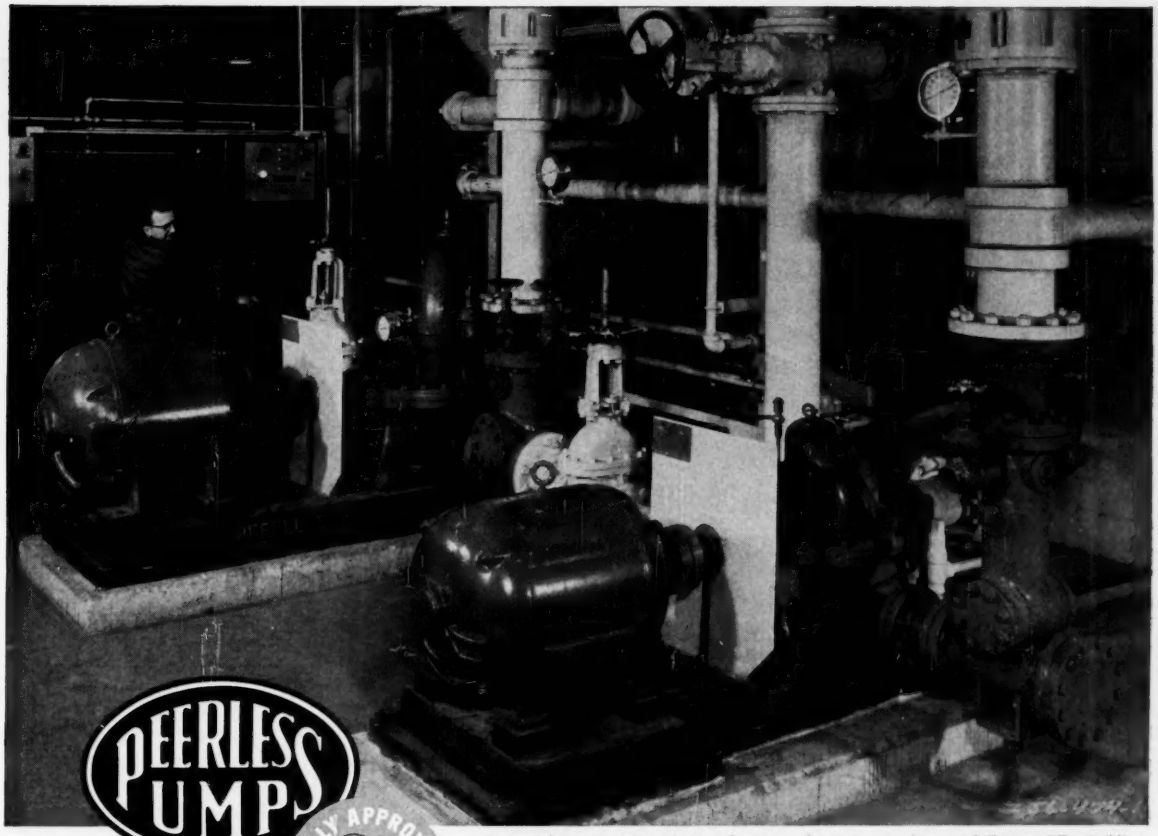
Receptacle for flush-wall mounting in hazardous atmospheres features an exclusive dead-end contact that confines arcing within a special chamber. Insertion of the plug into the receptacle, followed by a ¼-turn to the right, completes the circuit. — **Appleton Electric Co., Chicago, Ill. 150B**

Immersion pump will deliver 11,000 scfh. of nitrogen and 13,750 scfh. oxygen at pressures to 10,000 psi. Known as the HP-8, the reciprocating, single-action, positive-displacement pump is claimed to be the most compact and lightest unit of its type on the market. Sale is limited to firms under contract to the Armed Forces. — **Linde Co., New York, N. Y. 150C**

Equipment Cost Indexes . . .

	June 1958	Sept. 1958
Industry		
Avg. of all.....	230.7	230.9
Process Industries		
Cement mfg.	222.2	223.3
Chemical	231.7	232.3
Clay products	216.0	217.0
Glass mfg.	218.8	219.3
Paint mfg.	223.1	222.8
Paper mfg.	223.3	223.8
Petroleum ind.	227.9	227.5
Rubber ind.	230.7	230.3
Process ind. avg..	228.2	228.6
Related Industries		
Elec. power equip...	234.3	236.0
Mining, milling.....	233.1	233.7
Refrigeration	260.7	260.3
Steam power	218.4	218.1

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 125-6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143-4 for annual averages since 1913.



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FIRE PUMPS...

FULLY APPROVED
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FM

Prudential Insurance Co. takes no chances on fire in its recently erected Chicago Office Building. Peerless pumps give immediate protection against fire *automatically*, without human attention.

HOW TO DEAL WITH A FIRE BEFORE IT STARTS!

To insure adequate protection against the hazards of fire, a qualified independent fire protection system is a must. And to be doubly sure of the best system, the vital heart of the unit, the pump, should be the best money can buy. That's where Peerless *fully-approved* fire pumps excell.

Throughout a third of a century, Peerless fire pumps have attained an enviable and pre-eminent reputation in protecting all types of buildings, plants and warehouses. Put this know-how to work on your protection problem. See how Peerless' combination of top quality fire pump equipment, exacting engineering application and nationwide service can serve you best. In many instances, the savings effected thru more favorable insurance premiums can pay for the installation. For fire pumps at their very best look to the leader, look to Peerless. Write for bulletin B-1500 today.

Available with steam turbine, engine or electric motor drives, Peerless fire pumps are available for high pressure sprinkler systems, or foam smothering systems in every kind of commercial, or industrial installation.

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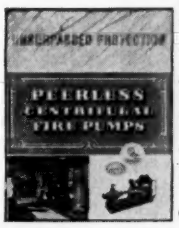
FOOD MACHINERY AND CHEMICAL CORPORATION

Putting Ideas to Work

Peerless Pump Division

Plants:
Los Angeles 31, Calif. and Indianapolis 8, Ind.



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TECHNICAL

Provocative and Stimulating

SOME PROBLEMS IN CHEMICAL KINETICS AND REACTIVITY, Vol. 1. By N. N. Semenov. Translated from the Russian by Michel Boudart. Princeton University Press. 239 pages, paper cover. $4.50.

Reviewed by Charles N. Satterfield, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

The appearance of a book on kinetics by N. N. Semenov, the Nobel laureate, is of first-rank importance to kineticists everywhere, and we are indebted to Prof. Boudart for making this very readable translation available. A first edition of the book was originally written by Semenov as a survey of the literature and personal critique for a Russian Symposium on Chemical Kinetics and Reactivity in 1955. The book was later expanded and the present Vol. I comprises the English translation of the first half of the work.

Volume I is concerned with reaction of radicals. This includes a wide range of topics: Relative reactivity of radicals; competition between reactions involving radicals; initiation, propagation, and termination of chain reactions and effects of walls.

This is not a book for the beginner, nor is it one that can profitably be dipped into here and there. The advanced worker in kinetics, however, will find it provocative and stimulating.

Fascinating, for example, are some of Semenov's ideas on the quantitative relationships between activation energy and heat of reaction and the application of these relationships in explaining relative reactivities of radicals. One is impressed by his methods of making simplifying assumptions in order to bring huge masses of data into some simple generalities, and by his techniques of quantitative estimation of probable rates of

BOOKSHELF

J. B. BACON

individual radical reactions as a method of indicating probable mechanisms.

Another valuable feature of the volume are the copious references throughout, particularly the apparently thorough coverage of Russian literature including very recent work.

Among chemical engineers the present volume will be of primary interest only to those engaged in fairly fundamental work in chemical kinetics—particularly gas phase or homogeneous processes. For them, however, the cliche applies: This is one they will want not to miss.

BRIEFLY NOTED

COMPILATION OF ASTM STANDARDS RELATING TO PLASTICS. *191 standards. American Society for Testing Materials,* 1916 *Race Street, Philadelphia* 3, *Pa.* $8. Adds 43 new standards, including specifications for nonrigid vinyl chloride plastic sheeting (D 1593); glass fabric-reinforced epoxy resin laminates (D 1592); polymethylstyrene molding and extrusion material (D 1595). Includes abbreviations of terms.

HEAT CAPACITY DETERMINATION OF MINERAL AND SYNTHETIC ENGINE OILS, LUBRICANTS, FUELS AND HYDRAULIC FLUIDS IN THE TEMPERATURE RANGE 70-500 F. 55 *pp. Midwest Research Institute for Wright Air Development Center. Order PB* 151210. *Office of Technical Services, U. S. Dept. of Commerce, Washington* 25, *D. C.* $1.50. Gives experimental data, describes design and operation of adiabatic calorimeter for measurement of heat capacities of liquid materials stable in the 70-500 F. temperature range.

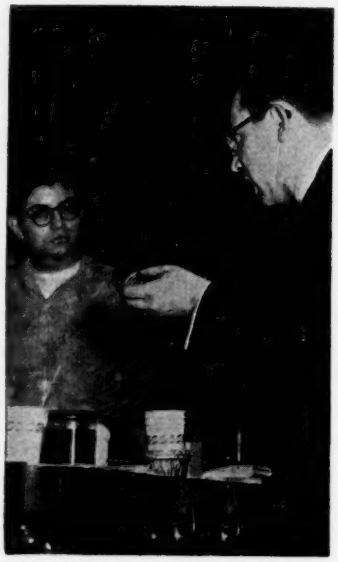
MORE NEW BOOKS

COMPANY CLIMATE AND CREATIVITY. By Deutsch and Shea, Inc. Industrial Relations News. $10.

THE ATOM AND THE ENERGY REVOLUTION. By Norman Lansdell. Philosophical Library. $6.

ORGANIC SYNTHESES. Edited by John C. Sheehan. Wiley. $4.

LETTERS:



Pro: Nationwide Program

Sir:

Mr. Cryden's article, "Engineers Go Back to High School" (Nov. 17, pp. 163-165), shows a very good idea. The working together of industry and education is a great necessity.

However, the whole idea should be handled on a nationwide basis, not by just a few companies or a few schools. How to do this? Simple: Create a government Department of Science, which would include the Office of Education.

ROBERT LOBSTEIN
Santa Monica, Calif.

Pro: More Initiative

Sir:

I note the lament of "Name Withheld" on page 160 of your Dec. 1 issue.

This is not the only complaint of this kind I have seen regarding wasted time in the military services, but my experience indicates that if an officer wastes his time in the service it is largely his own fault.

The military services are more than desirous of using personnel to the best advantage. I have

PRO & CON

C. H. CHILTON

had 40 years in the Reserve, and I have found that officers who are content to lie around in "gravy-boat" jobs and who do not seek out opportunities are not respected nor advanced.

I have just returned from a four-weeks' trip which gave me opportunity to observe and talk with officers and enlisted men at Rhein-Main Air Base, Wiesbaden, Paris, Torrejon (Spain) and Kindley (Bermuda). It is true that there may not be a chemical engineering job at hand for the budding chemical engineer and that technical officers have been used on non-technical jobs.

But these jobs are not "such that an intelligent clerk could fill them." They are responsible executive positions, handling personnel, transportation, commissaries, hotels, etc., all of which will give an alert man a broadening-out experience that should make him a better engineer when he returns to civil life. Every post also has schools for advanced study to which officers can be assigned for part-time or evening studies.

Officers are not placed on clerical jobs unless they are poor ratings whom the services would like to see resign.

GEORGE S. BRADY
Colonel, USAR, Ret.
Bethesda, Md.

We're Really Up-to-Date

Sir:

I wanted you to know that it took a wide-awake chemical engineer like me only about three months to notice that my Sept. 8, 1958, issue read "Vol. 67, No. 18" on the cover, rather than the correct figure, Vol. 65, as noted inside.

This is a good illustration that your magazine must not only be read cover to cover, but that the cover itself must also be read to keep up with all latest developments.

And speaking of covers, your

PRO & CON . . .

High Temperature cover (Mar. 1957) was the greatest.

JAMES F. SHORT
Smith-Douglass Co.
Norfolk, Va.

Pro: First Person

Sir:

Re: You and Your Job, Nov. 3 (pp. 147-148).

Dandy, just dandy. This series continues to reach a high standard in every article. While some of them are of more use to other people, the periodic items on report writing are just what I need.

Could I have a couple of tear-sheets of Mrs. Cortelyou's article on use of the first person in technical writing? I would like to reproduce it by offset for class use.

As fast as I put out these items they are snapped up by all our students.

D. A. REDMOND
Nova Scotia Technical College
Halifax, Canada

CE's History

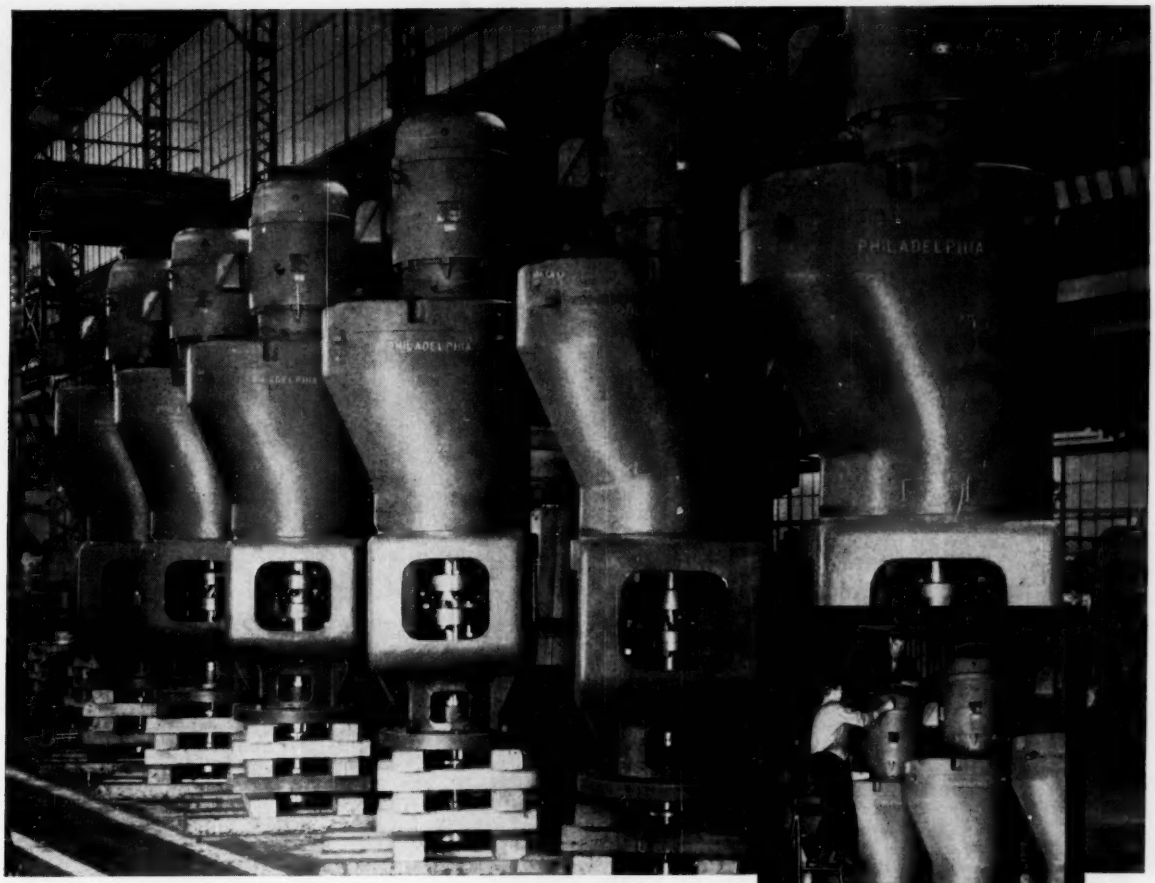
Chemical Engineering, with which is incorporated *Chemical & Metallurgical Engineering*, is the successor to *Metallurgical & Chemical Engineering*, which in turn was a consolidation of *Electrochemical & Metallurgical Industry* and *Iron & Steel Magazine*.

The magazine was originally founded as *Electrochemical Industry*, in September 1902, and was published monthly under the editorial direction of Dr. E. F. Roeber. It continued under that title until January 1905 when it was changed to *Electrochemical & Metallurgical Industry*. In July 1906 the consolidation was made with *Iron & Steel Magazine* which had been founded eight years previously by Dr. Albert Sauveur. In January 1910 the title was changed to *Metallurgical & Chemical Engineering*, and semi-monthly publication was begun Sept. 1, 1915. On July 1, 1918, the title was changed to *Chemical & Metallurgical Engineering* and weekly publication was begun Oct. 1, 1919. Monthly publication was resumed in March 1925.

In August 1946 the words "*& Metallurgical*" were dropped from the main title to bring its name more in keeping with the editorial content. Biweekly publication began in January 1958.

Dr. E. F. Roeber was editor of the paper from the time it was founded until his death Oct. 17, 1917. After a brief interim he was succeeded by H. C. Parmelee. Ten years later, Nov. 1, 1928, Dr. Parmelee assumed other responsibilities in the McGraw-Hill Publishing Company and Sidney D. Kirkpatrick was appointed editor.

Dr. Kirkpatrick was named editorial director July 1, 1949, and at that time he was succeeded as editor in chief by John R. Callaham.



Each of these mixers weighs over four tons, yet they are so perfectly balanced they stand alone on their supporting blocks. Side support is not required. This means minimum stress on tank top flanged nozzles which support the mixers.

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42 PHILADELPHIA MIXERS

Forty-two vertical Philadelphia Mixers like the ones shown are being installed at the Baton Rouge Refinery of Esso Standard Oil Company by Foster Wheeler Corporation. They are part of an alkylation process in which concentrated sulfuric acid serves as a catalyst to unite light olefins and isobutane to produce high octane gasoline blend stock. Installed in the various reaction zones of the reactors, they insure optimum contact of reactants.

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Dear Readers:

In a fast-moving field such as urea, your editors occasionally find threads of several stories rolling up into one ball of wax. That's why you'll find the Processes & Technology department and Process Flowsheet of this issue featuring unusually complete coverage of what's happening in urea synthesis.

It all started in July 1957, when Developments Editor Cecil Chilton asked Frank Byrnes, then *CE's* Midwest Editor, to develop a story with Spencer Chemical Co. about its new urea plant at Vicksburg, Miss., which used the Montecatini process. This started negotiations with Spencer in Kansas City and Montecatini in Milan that lasted until Montecatini's final approval of story filed by Midwest Editor Pete Forbath in October 1958.

Meanwhile, Pete opened negotiations last April with Vulcan-Cincinnati for a Process Flowsheet on the Inventa-Vulcan urea process.

Still another thread was picked up in April, when Dr. Paul Ferrero, speaking about the chemical industry in the Benelux countries before an AIChE meeting in Montreal, disclosed that "an interesting original process for urea synthesis" was operating commercially in the Netherlands. Follow-up by *CE* editors led us to Staatsmijnen (Dutch State Mines) in Holland. McGraw-Hill World News Correspondent Paul Catz in Amsterdam gathered information about the DSM process.

Late last summer it became apparent that these three stories would be ready to publish at approximately the same time. Therefore, we decided to round out the picture by going after the latest information on Chemico's and Foster Wheeler's processes and shoot the works in this issue. Assistant Editor Roland (Clem) Labine coordinated and edited the final stories.

CALVIN S. CRONAN
Associate Editor
Chemical Engineering

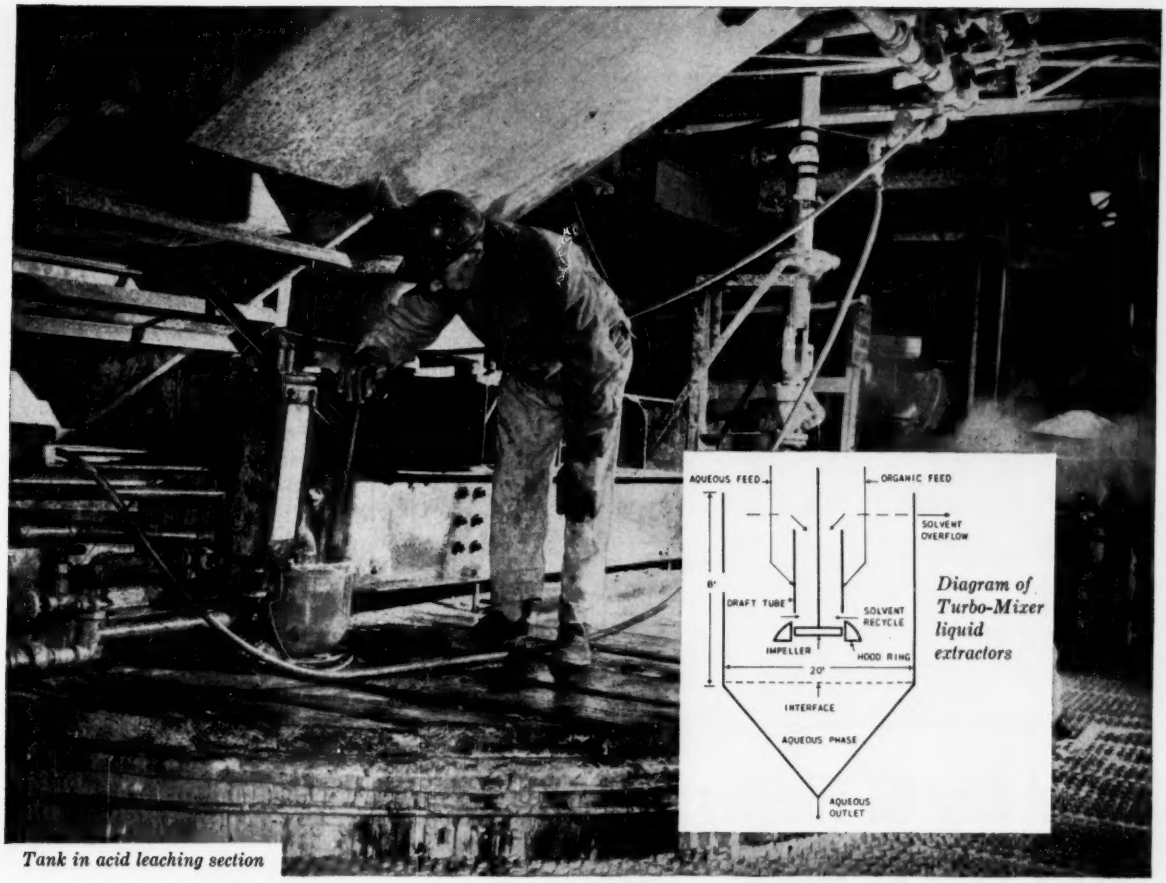

Diagram of Turbo-Mixer liquid extractors

Tank in acid leaching section

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TECHNICAL

Contents of This Issue

Chemicals

Aluminum Salts.....2 p. bulletin describes the effectiveness of a 40% aqueous solution of aluminum hydroxy chloride in antiperspirant sticks.
160A Waverly Chemical Co.

Catalysts.....An experienced technical staff will assist you in developing the best & most economical catalyst. Available in tablet, powder, granule forms etc. Booklet.
65 *Harshaw Chemical Co.

Caustic Soda.....A new 86-page handbook is now available. It contains complete, authoritative information on Caustic Soda. Other information on chemicals is available.
8-9a *The Dow Chemical Co.

Chemicals . . . . . Complete technical data is available on anhydrous ammonia, ammonium nitrate, ethylene oxide, ethanolamines, formaldehyde, urea, methanol, etc.
47 Allied Chemical, Nitrogen Div.

Chemicals.....6 p. leaflet, "New Chemicals for Industry—1958," gives brief descriptions of 33 organics. Covers properties, uses, availability.
160B Union Carbide Chemicals

Chemicals, Organic.....1959 edition of "Physical Properties," 28 p., covers over 400 synthetic organic chemicals. Tabulates carefully determined physical properties.
160C Union Carbide Chemicals

Chloromethoxypropyl Mecuric Acetate . . . . . Solutions now available in commercial quantity. Fungicidal & bactericidal activity claimed superior to phenyl mercuric mixes.
17-18i *U. S. Industrial Chem. Co.

Cosmetic Technology.....is discussed in new, 1450 page book now being sold. Includes technology, historic & legal aspects, physiology, testing, manufacture.
17-18g *U. S. Industrial Chem. Co.

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LITERATURE

E. M. FLYNN

Denatured Alcohol.....Shortage of Brucine denaturant made modifications necessary. There are now three new SDA 40 formulations approved and authorized.
17-18a *U. S. Industrial Chem. Co.

Hexachloractone.....is a strongly ketonic, non-flammable chemical intermediate & selvent. The Product Information Data Sheet on Hexachloracetone is offered.
41 *Allied Chem., Gen. Chem. Div.

Ion-Exchange Resins.....New analytical-grade based on cellulose are claimed suitable for chromatographic fractionations of high-molecular-weight materials.
17-18o *U. S. Industrial Chem. Co.

Lacquer.....1 p. flyer illustrates application and describes spray-on touch-up lacquer which matches control penel colors making touched up blemishes unnoticeable.
161A Panellit, Inc.

L-Methionine.....labeled with both carbon 14 & deuterium can now be obtained for research purposes. This amino acid useful in studying the mechanism of ergosterol.
17-18f *U. S. Industrial Chem. Co.

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17-18d *U. S. Industrial Chem. Co.

Methocel.....A 60-page handbook contains facts on the versatility of Methocel as a thickener, stabilizer, film former, emulsifier & binder. Copies available.
8-9b *The Dom Chemical Co.

Pnenolic Resins.....8 p. brochure, CDC-358, describes company's complete line of phenolic resins, varnishes and molding powders. Detailed technical data.
161B General Electric Co.

Plastics.....64 p. catalog of products handled by this company includes sections on Plexiglas, vinyls, acetates, phenolic laminates, nylong, Teflon, coatings.
161c Commercial Plastics & Supply

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LITERATURE . . .

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17-18k *U. S. Industrial Chem. Co.

Rigid Polyurethane Foams.....Formed by mixing polyisocyanates & polyesters. Material is proving ideal for industrial & home insulation, packaging applications, etc.
17-18b *U. S. Industrial Chem. Co.

Silicones.....16 p. 1959 reference guide to company's silicone products, their function in adhesives, release agents, resins, rubbers, dielectrics, water repellents.
162A Dow Corning Corp.

Sodium Alkoxide Preparation.....by dryway process. New technical bulletin describes technique for preparing sodium alkoxides from metallic sodium & alcohol vapors.
17-18e *U. S. Industrial Chem. Co.

Urethane.....Reference guide NA46 includes calculations needed in urethane technology, explains terms used in formulating foam, coatings, adhesives.
162B Allied Chemical

Urethane, Rigid Foams.....6 p. bulletin No. 71558 describes polyesters for rigid foam called Nacconate 1080-H. Tabular data on formulations, properties.
162C Allied Chemical

Construction Materials

Coatings, Protective.....Information on Tarmastic, Tarset and Insul-Mastic coatings is available. These heavy duty cold applied coatings handle particular problems.
55 *Pittsburgh Coke & Chem. Co.

Coatings, Resin-based.....guard paint production equipment from corrosion. Booklet, "Epon Resin Esters For Surface Coatings" is now available.
Cover *Shell Chemical Corp.

Hastelloy C.....Technical literature combines latest data pertaining to Hastelloy C under one cover. Chemical, physical and mechanical properties; corrosion data.
162D Haynes Stellite Co.

Insulation.....Foamglas is the only cellular glass insulation. It is moisture-proof, dimensionally stable, acid-proof, vermin-proof, etc. Literature offered.
20-21 *Pittsburgh Corning Corp.

Insulation.....Calsilite is a modern molded calcium silicate insulation for use on today's high temperature pipes & vessels. One layer does the complete job. Details.
R189 *The Ruberoid Company

Nickel Alloys.....A new booklet "Handling Fluorine and Fluorine Compounds with Inco Nickel Alloys" showing many industry proven appications is offered.
143 *The International Nickel Co.

Paint.....8 p. "How to Strip Paint" covers the procedure, equipment and chemicals used. Photographs show each step of various procedures.
162E Oakite Products, Inc.

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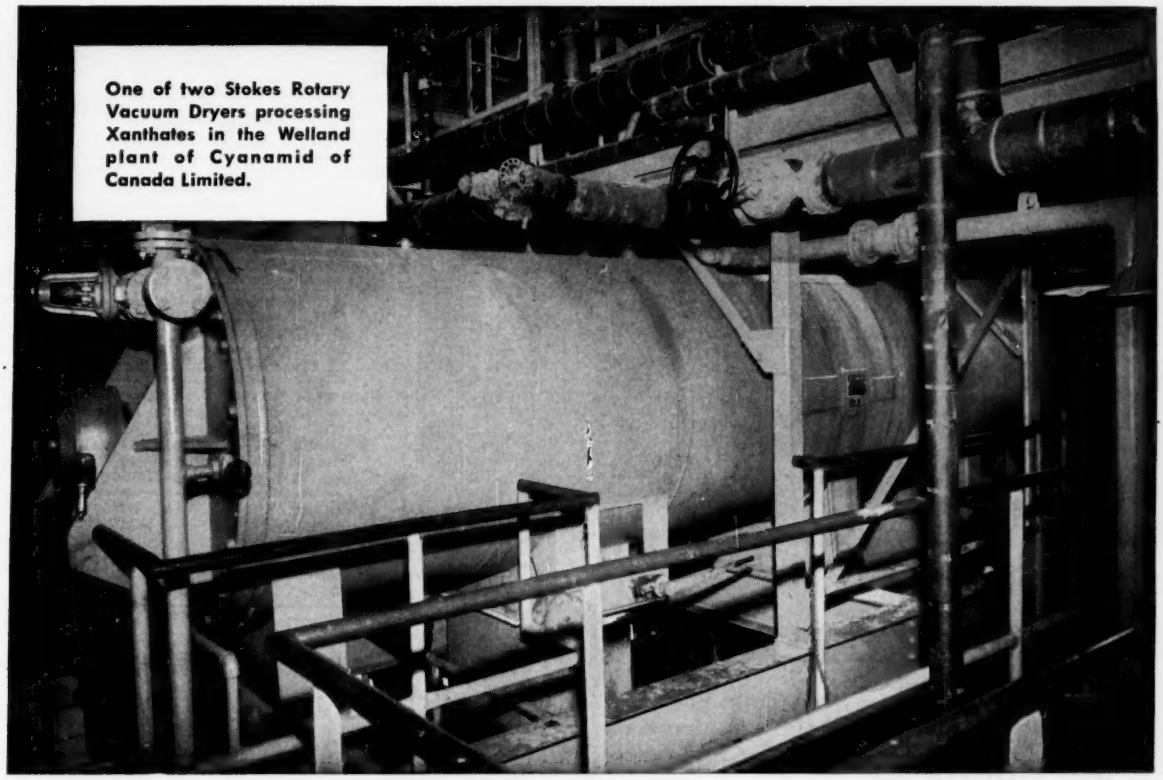

One of two Stokes Rotary Vacuum Dryers processing Xanthates in the Welland plant of Cyanamid of Canada Limited.

Stokes Rotary Vacuum Dryers process Xanthates for Cyanamid of Canada Limited

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STOKES

LITERATURE . . .

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164A Joseph Dixon Crucible Co.

Rubber Linings.....expand & contract with the metal under temperature changes . . . won't harden or crack. Offer protection for your processes & equipment.
83 *Raybestos-Manhattan, Inc.

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17-18j *U. S. Industrial Chem. Co.

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63 *E. I. du Pont de Nemours & Co.

Titanium Sheet.....is available in gauges from .015" to .125", from ⅛" to 1½" diamonds, & in standard 48" x 96" sheets. Technical Data Sheet is offered.
24 *Mallory-Sharon Metals Corp.

Electrical & Mechanical

Bearings, Bushings.....A 70-page book describes the complete line of the manufacturer's oilless wood, graphite and sintered metal bearings, bushings and machine parts.
164B Wakefield Bearing Corp.

Bus Conductor.....Aluminum bus is easy to handle & fabricate and is available in a wide variety of sizes. The Aluminum Bus Conductor Handbook is offered.
125 *Aluminum Co. of America

Couplings, Spacer.....is specially designed for quick installation or removal without disturbing the driving or driven unit. Copies of Service Manual 4838 available.
16 *The Falk Corporation

Electrical Equipment.....The Hazard Finder will enable you to make a quick survey of hidden probabilities of electrically-ignited explosions in your plant.
36 *Crouse-Hinds Co.

Gas Turbine Drivers.....Bulletin 166 presents an analysis of the economic aspects of combustion gas turbine application in the refining industry. Illustrated.
164C Clark Bros. Co.

Generators.....New line of high-speed synchronous generators comes in sizes from 50 to 187 kva., 60 or 50 cycles. Publication 2100-PRD-251 details construction.
164D Electric Machinery Mfg.

Integral-Shaft Sheave.....Construction and operating features of the Vari-Pitch integral shaft sheave for speed control is the topic of a new bulletin, No. 20B7897B.
164E Allis-Chalmers

Limit Switches . . . . . Newly revised Catalog 83C covers a complete line of industrial enclosed limit switches. Details of nine housing groups that are explosion-proof.
164F Micro Switch

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159c—Side-entering Propeller Mixer
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168a—Mixers
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- CE Flow File (50¢).....112

*Don't forget to ask for your free file copy of this issue's reprint feature (p. 101).

LITERATURE . . .

Mechanical Seals.....A line of precision shaft seals is the topic of a new four-page bulletin. Ranges for standard types are listed. Custom models offered.
168A Borg-Warner Corp.

Motor Control.....New, Shelter-Clad walk-in enclosures provide complete protection for personnel & motor control. Units meet NEMA 3 & 4 standards. Details.
61 *Allis-Chalmers, Gen. Prod. Div.

Motor-Starter.....Bulletin 709 gives details on across-the-line solenoid starters. Made in nine sizes with maximum ratings up to 450 hp, 220 volts; 900 hp, 440-550 volts.
141 *Allen-Bradley Co.

Plastics Welders.....High speed hand welders for thermoplastics are pictured and described in a new 4-page bulletin. Information on welding speeds and strengths.
168B Laramy Products Co.

Starter, Air-break.....Type ZHA has a certified interrupting capacity of 100,000 KVA at 2400 volts, 150,000 KVA at 4800 volts. Complete story in Bulletin 8130.
121 *The Electric Controller & Mfg. Co.

Switches.....Series EX1 switches have a conduit opening at both ends of the housing. Series EX type AR have single conduit openings. Details in Catalog 83.
127a *Micro Switch

Switches, Explosion-proof.....Catalog 84 features the "ML-E1" series. This series of explosion-proof limit switches meet a wide range of requirements as outlined.
127b *Micro Switch

Switchgear.....New bulletin gives information on a line of 4,160-v. metal-clad switchgear. Ratings through 3,000 amp. continuous-current and 350-mva. interrupting.
168C I-T-E- Circuit Breaker Co.

Turbine, Gas—The new 1100 hp gas turbine is extremely lightweight and occupies only about 51 cubic ft. It will operate on a variety of fuels. Details.
30 *Solar Aircraft Co.

Handling & Packaging

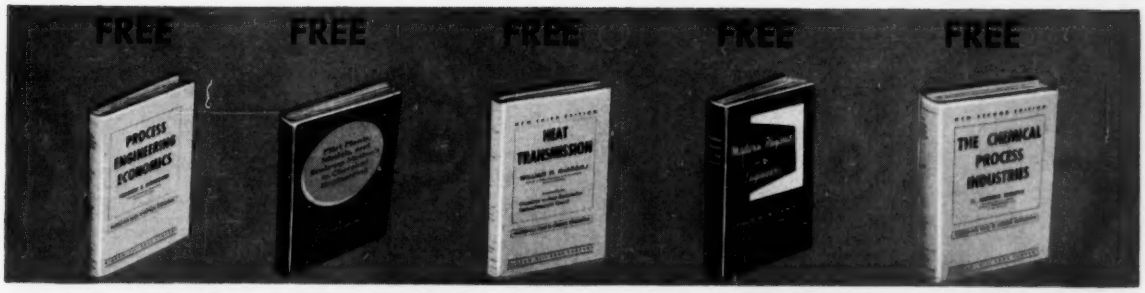
Conveyor, Air-gravity.....Air-Float for efficient dry solids conveying. The aerated material flows by gravity. Complete facts contained in Bulletin 58-K.
49 *Kennedy Van Saun

Cylinders.....for high & low pressure shipment of compressed gas. Uniform weight & capacity simplify filling, handling & record-keeping. Wide range of types.
13 *Pressed Steel Tank Co.

Elevator.....The Rotor Lift handles dry, free-flowing bulk materials with capacities to 6,000 cu. ft. Available vertical or inclined.
*Southwestern Supply & Mach.
R177

Hydraulic Tripper.....handles all materials safely. Feature hydraulic control throughout. Can be supplied with fire-resistant material in hydraulic system. Details.
138 *Continental Gin Co.

* From advertisement, this issue



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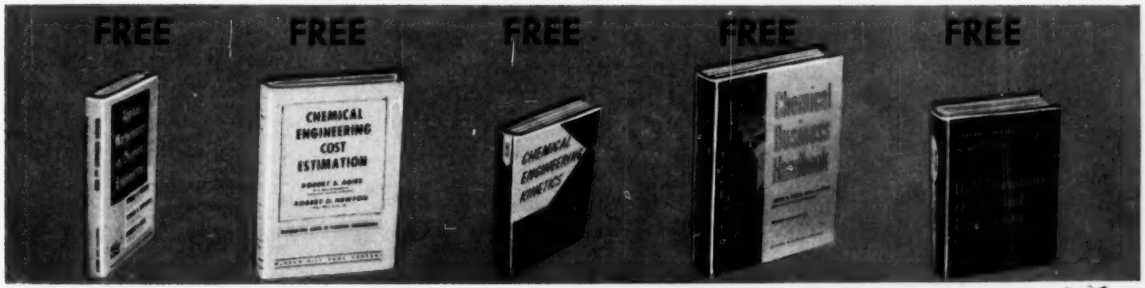

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☐ **Process Engineering Economics** by H. E. Schweyer. Publisher's Edition $8.00. Club Price $6.80.

☐ **Pilot Plants and Scale-up Methods in Chemical Engineering** by R. E. Johnstone and M. W. Thring. Publisher's Edition $10.00. Club Price $8.50.

☐ **Heat Transmission** by W. H. McAdams. Publisher's Edition $9.50. Club Price $8.10.

☐ **Modern Physics for the Engineer** edited by L. Ridenour. Publisher's Edition $8.25. Club Price $6.95.

☐ **The Chemical Process Industries** by R. N. Shreve. Publisher's Edition $12.00. Club Price $10.25.

☐ **Applied Mathematics in Chemical Engineering** by H. S. Mickley, T. K. Sherwood, and C. E. Reed. Publisher's Edition $9.50. Club Price $8.10.

☐ **Chemical Engineering Cost Estimation** by R. S. Aries and R. D. Newton. Publisher's Edition $6.50. Club Price $5.50.

☐ **Chemical Engineering Kinetics** by J. M. Smith. Publisher's Edition $8.50. Club Price $7.25.

☐ **Chemical Business Handbook** by J. H. Perry. Publisher's Edition $31.00. Club Price $17.85.

☐ **Unit Operations of Chemical Engineering** by W. L. McCabe and J. C. Smith. Publisher's Edition $11.00. Club Price $9.35.

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CE-1-26

LITERATURE . . .

Lift Truck.....The FT 30-24 features a heavy-duty industrial engine with full 35 hp, 97 ft-lb of torque. It climbs a 40-percent ramp loaded. Bulletin BU-485.
33 *Allis Chalmers

Materials Handling.....Dinosaur is a system of materials handling that employs giant containers up to 40 cu. yds. & larger. Booklet describes system in detail.
171 *Dempster Brothers, Inc.

Materials Handling Truck.....The Liftomatic is designed & constructed to eliminate use of hooks, & additional man-power in moving containers & chimes.
170A Marvel Industries, Inc.

Oscillating Conveyors.....New 24-page book is claimed to describe the most complete line of oscillating conveyors. Three types cover capacity span of 25 to 350 tons/hr.
170B Link-Belt Co.

Power Truck Attachment.....fits any truck & handles any drum. Illustrated bulletin offers complete specifications & other details of this Lifomatic attachment.
170C Marvel Industries, Inc.

Heating & Cooling

Burning Systems.....New 8-page bulletin lists 11 sizes of oil, gas and combination gas and oil burners for firing boilers or other heat exchange equipment.
170D Orr & Sembower, Inc.

Combustion Systems.....High-velocity air heating combustion systems are individually job engineered using standard components. Complete information on request.
174 *Eclipse Fuel Engineering Co.

Deaerating Heaters.....Revised and enlarged bulletin presents information on tray type deaerating heaters. Coverage includes principles, design, installation, etc.
170E Graver Water Conditioning

Drawer-Type Ovens.....Seven of the manufacturer's series of drawer-type forced-convection ovens for pre-heating and drying are illustrated and described in LS-201-2.
170F Despatch Oven Co.

Drying Oven.....Complete information available for the heat processing industry. Solve heat problems, large or small. These ovens adhere to close heat tolerances.
43 *Despatch Oven Co.

Electric Heat.....Strip heaters or Tubular heaters meet your specific requirements. Chromalox Thermwire Tape & Cable for problems solved by low temp. localized heat.
136 *Edward L. Wiegand Co.

Fireproofing.....Complete technical data including specifications, UL ratings and application data are featured in bulletin on machine-applied fireproofing.
170G Columbia Acoustics

Heat Exchanger.....Improved "compression head" is illustrated and described for a new type of impervious graphite heat exchanger. Models from 21 to 470 sq. ft.
170H Falls Industries, Inc.

* From advertisement, this issue

New Invention Picks Up 40 Cu. Yd. Detachable Containers . . . 15-Ton Loads

Dinosaur picks up in excess of 30,000 pounds of granular material, white line inside container indicates load has not shifted.

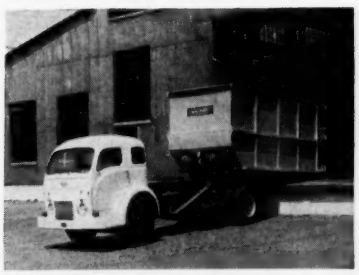
DEMPSTER-DINOSAUR Combines Detachable Container Flexibility With Big Pay-Load Capacity

Unlimited Capacity

The proven savings of mechanically handled detachable containers have now been expanded to cover long, over-the-road hauls. Two DINOSAUR models are available for this work. One, for tandem trucks, handles 30,000 pounds; the other, for single axle trucks, handles 22,000 pounds. Special off-the-road models are available for loads limited only by the capacity of the truck.

For Docks and Flat Cars

Mechanically, the DEMPSTER-DINOSAUR is of extremely simple design. Components are a tipping frame, two hydraulic raise-and-lower cylinders and a double-acting cylinder which controls all container movements. No chains, sheaves or cables are used in its operation. It is the only over-the-road system that can push and pull containers on and off docks or railroad flat cars. This makes it possible to use the DINOSAUR in conjunction with "boxy-back" containerized cargo rail shipments.



The Dinosaur hydraulically pushes a container off on a dock and inside a building for unloading.

Many Sizes and Types of Containers are Available

DEMPSTER-DINOSAUR standard containers come in 21 sizes ranging from 14½ feet to 23½ feet in length and 10 to 41 cu. yd. capacity. Special cargo containers up to 35 feet, tank-type and stake side models are also available. Drop-down telescopic legs to hold container at dock height are optional on some cargo containers.

Free Booklet Offered

A free booklet which describes the operation of this new system in detail is offered by Dempster Brothers, the originator and only manufacturer of DEMPSTER-DUMPSTER Systems.

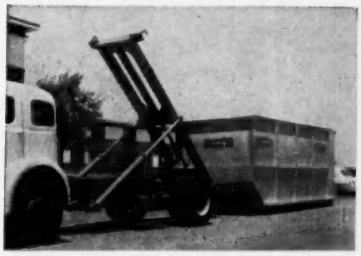
Mfd. By Patents Pending

DEMPSTER BROTHERS, Inc.

Dept. CE-1, Knoxville 17, Tenn.

Containerized Cargo, Waste & Raw Materials Handled by DINOSAUR

The newly developed DEMPSTER-DINOSAUR is a system of materials handling that employs giant containers up to 40 cubic yards and larger. It lends itself to any situation where bulk accumulations of raw materials, liquids, waste or finished products must be handled. Since one truck and one driver can automatically pick up, haul and dump or set down a number of containers, the DINOSAUR easily does the work of several trucks.



Dinosaur backs up to loaded container and engages it with lifting bail.

Container is hydraulically pulled up inclined tilting frame.

Container is pulled forward where it automatically locks into carrying position.

LITERATURE . . .

Heat Exchanger.....Aero Heat Exchanger is a self-contained fluid cooling system. It offers accurate temperature control. Bulletin No. 132 is available.
B188 *Niagara Blower Company

Heat Exchangers.....Bul. 817 describes VMC ammonia compressor. Bul. 707 condensers, brine coolers & heat exchangers. Information on industrial types in Bul. 427.
170 *Vilter Manufacturing Co.

Heat Exchangers.....Scraped surface exchangers handle special heat transfer problems such as; surface fouling, crystallization, etc. Bulletin PE-1.
86 *Henry Vogt Machine Co.

Heating, Ventilating Units.....New product bulletin describes complete line of Herman Nelson heating and ventilating units. Capacities to 73,000 cfm.
172A American Air Filter Co.

Horizontal-Grate Cooler.....Bulletin CO-6 discusses advantages of the new Fuller horizontal-grate cooler, which is designed to cool materials from kilns, roasters, etc.
172B Fuller Co.

Refrigeration Equipment.....for quick freezing, ice making, cold storage, humidity control, condensing, air conditioning or any process cooling. Details on request.
155 *Frick Co.

Instruments & Controls

Centralized Control Systems.....Bulletin 106 illustrates and describes the design approach, materials and construction of centralized control systems.
172C Panellit, Inc.

Controller.....Pyr-O-Volt is an accurate instrument for reliable stepless control of saturable reactors, r.f. generators and other power amplifiers. Details available.
6-7 *Minneapolis-Honeywell

Controllers Recorder . . . . . Dynalog Electronic Recorders-Controllers-Indicators deliver accurate, sensitive measurement of ph & other variables as well. Bul. 20-10.
149 *The Foxboro Company

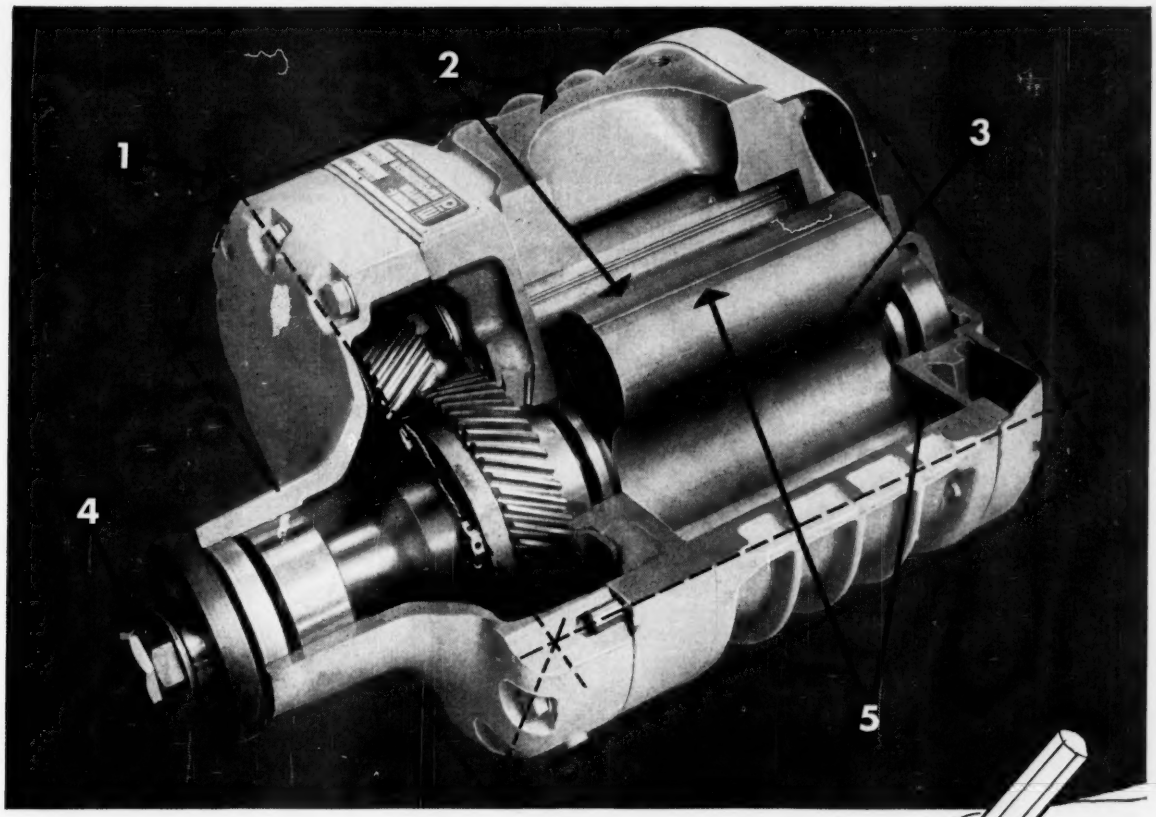
Controls, Temperature.....Details of the pneumatic, electric or self-contained gas control (recording, indicating or non-indicating) are available on request.
119 *The Partlow Corp.

Electronic Counters . . . . . Four-page bulletin describes uses, design characteristics, maintenance and operating features of new totalizing and predetermined counters.
172D The Redford Corp.

Instruments.....Solve problems in recording & indication. Complete information on engineering, service and installation is available on request.
76 *The Bristol Company

Instruments.....Bulletin & full details on electronic instruments including instantaneous sensing & transmitting units, AC or DC Recorder & AC or DC Controller.
10-11 *Taylor Instrument Companies

* From advertisement, this issue



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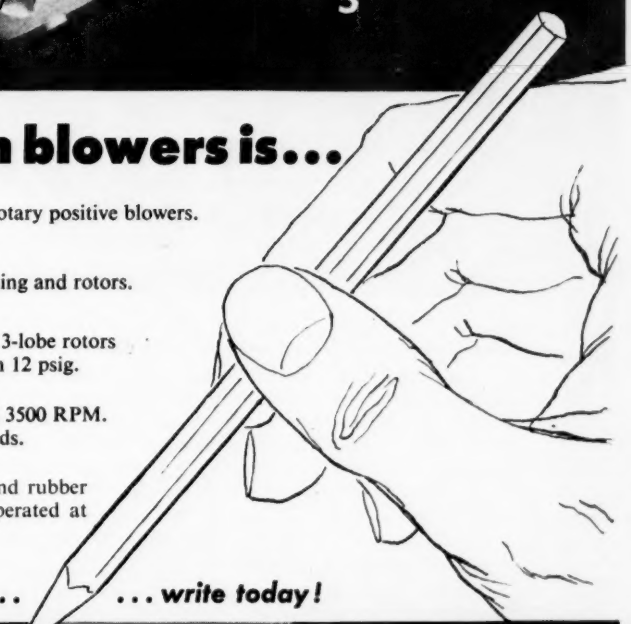

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Miehle Dexter

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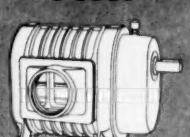

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M-D BLOWERS, INC., RACINE, WISCONSIN.

A subsidiary of Miehle-Goss-Dexter, Inc.

LITERATURE . . .

Liquid Level Control.....Bulletin F-85 describes the electric Type 2300 Level-Trol. Unit delivers a proportional 1-5-ma. d.c. signal through a 3,000-ohm load.
174A Fisher Governor Co.

Pressure gages.....Featuring the newly designed Safe-T-Case, the complete line of Helicoid gages is graphically described and illustrated in Catalog DH-65.
174B American Chain & Cable

Pipe, Fittings, Valves

Drainage Products.....New condensed catalog of drainage and construction products for industrial uses is available. Data on metal pipe, asbestos-bonded pipe, etc.
174C Armco Drainage

Fittings.....Speedline fittings feature flange without welding, leakproof union joints and easier, faster alignment. The Speedline Catalog is offered.
73 *Horace T. Potts Co.

Expansion Joints.....protect piping from damage caused by shock, vibration, expansion or contraction. Teflon expansion joints for handling corrosives. Folder AD-137.
77 *The Garlock Packing Co.

Line Strainers.....for spray nozzle systems & related applications in stainless steel, cast iron & brass. Easily flushed. Bulletin 94 for complete information.
T188 *Spraying Systems Co.

Pipe.....Bondstrand fiber glass reinforced epoxy pipe holds up under the corrosive action of many salt, acid and alkaline solutions. Easy to install.
135 *Amercoat Corporation

Pipe, Aluminum.....now a complete corrosion-resistant pipe that welds rapidly & easily. Won't contaminate or discolor fluids. Literature is available.
22-23 *Reynolds Metals Co.

Pipe, PVC.....is available in sizes ¼" through 6" in schedules 40, 80, and 120. A new 32-page illustrated catalog on this pipe is available. Send for your copy.
59 *A. M. Byers Co.

Seals.....Complete information on types of seals to meet your sealing needs are contained in Catalog No. 480 which is available on request. Send for your copy.
R187 *Durametallic Corp.

Tubes.....New brochure entitled "The Measure of Tubemanship" acquaints industry with skells and techniques necessary to manufacture of seamless copper tubing.
174D Wolverine Tube

Unions.....offer the widest application in high pressure-high temperature piping. Booklet "What makes a good union?" is now available.
146 *Clayton Mark & Co.

Valve, Drain or Sampling.....is completely self-draining and withstands severe conditions. Copies of a data unit and complete details of sizes, etc. offered.
L178 *Jerguson Gage & Valve Co.

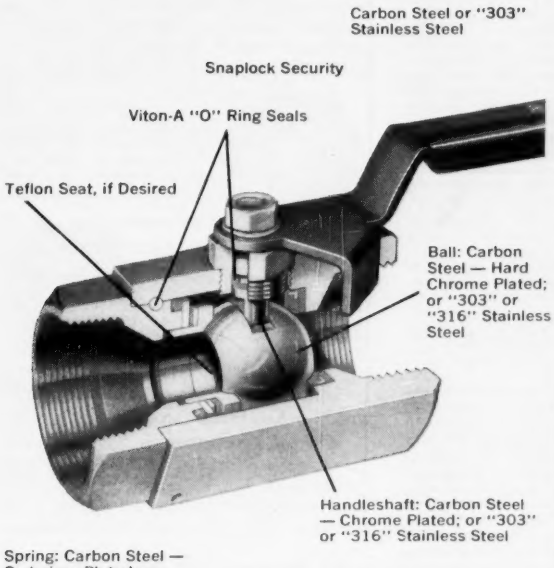
* From advertisement, this issue

Rockwood Ball Valves

Secure in seconds...

Snaplock Type

(now available with Viton-A trim)



300 p.s.i. — W.O.G.

Sizes: ¼" thru 2"

Securely locked — cannot be accidentally opened or closed.

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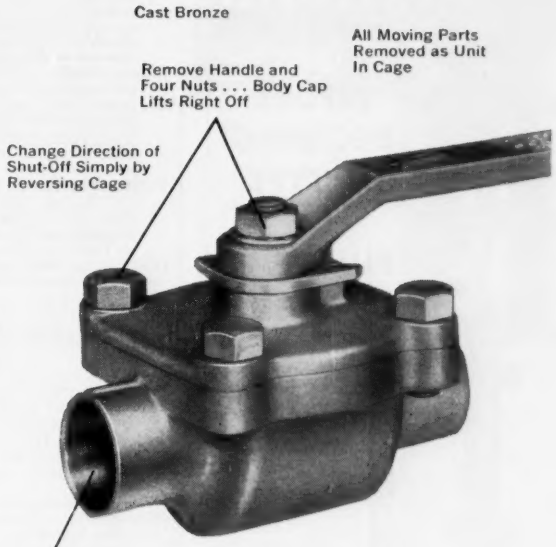
Top Entry Type



300 p.s.i. — W.O.G.

Sizes: ½", ¾", 1" and 2½"

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Whether it's positive security against accidental operation you're looking for or extra-easy servicing, you'll find the valve that fills your exact needs in the Rockwood line. And — you'll get all the Rockwood extra-performance features such as: ¼ turn opening and closing, 8-position lever operation, plus that smooth, full, round flow. Mail coupon for complete specifications.

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LITERATURE . . .

Valves.....available in 15 sizes, designed to meet over 300 variations in installation requirements. A new booklet CE 19 contains additional information.
154 *Durabla Mfg. Co.

Valves.....Multiport for 3-way & 4-way flow control with one valve. Complete line of lubricated plug valves, both Multiport & Straight-way. Details available.
139 *Rockwell Mfg. Co.

Valves.....New 432-page catalog covers manufacturer's line of valves, fittings, flanges and unions. Book discusses new types and trims for severe handling duties.
176A Henry Vogt Machine Co.

Valves, Ball.....feature two sealing surfaces & handle wide range of liquids & gases. They are easily adapted for remote control devices. Literature available.
145 *Jamesbury Corp.

Valves, Pinch.....handle pressures to 150 psi & temperatures to 200 F. Can be equipped for automatic regulation. New catalog gives data & recommended applications.
142 *The Mine & Smelter Supply Co.

Process Equipment

Blenders.....Specialized information and complete data contained in Bulletin No. 16, Chemical Process Equipment & Bulletin No. 15A-1, Twin-Shell Laboratory Blenders.
38-39 *Patterson-Kelly Co.

Blenders.....Rotary Blenders start 4-way blending while charging, continue it during discharge, producing even blends of dry & semi dry materials. Bulletin 080B.
R176 *Sturtevant Mill Co.

Centrifugals.....Descriptive Data Unit No. 2646 gives complete information on the special features of these centrifugals for use in the chemical process industry.
162 *The Western States Machine Co.

Centrifuges.....The C-41 Super-D-Hydrator is the largest of 3 high efficiency crystal drying centrifuges designed for both atmospheric & pressurized operation.
147 *The Sharples Corporation

Dryers.....Complete information on rotary vacuum dryers, rotating vacuum dryers, vacuum shelf dryers, drum dryers & flakers, tabletting equipment, etc. is offered.
163 *F. J. Stokes Corp.

Dryers, Steam Tube.....Fabricated of aluminum, nickel, monel, inconel, stainless steels & other alloys to protect against corrosion & contamination. Bulletin 16-D-11.
140 *Hardinge Company, Inc.

Drying Equipment.....guaranteed for paint pigments, tobacco, leather, fabrics, foods & drugs. Copies of the new Proctorpak bulletin are now available.
115a *Proctor & Schwartz, Inc.

Dust Control.....Duclones are available in a wide range of capacities & in multiple units & special materials for a wide variety of dry dust control uses. Bul. C-958.
4 *The Ducon Company, Inc.

* From advertisement, this issue

LITERATURE . . .

Dust Controls.....An extensive line of wet & dry collectors for any problem. Bulletin "Out of the Realm of Dust" gives detailed information.
57 *Pangborn Corporation

Feeders, Airlock.....available in standard duty, heavy duty, & blow-thru types. Booklet P-58, "How to Select A Rotary Airlock Feeder", is offered.
B186 *Prater Pulverizer Co.

Filter Press.....available in a design & capacity to handle any filterable mixture & any filter material. Catalog contains erection, operating, & construction data.
153 *D. R. Sperry & Co.

Gas Scrubbers.....New illustrated, data-packed brochure gives full details on how this equipment provides clean economical performance in industrial applications.
12 Chemical Construction Corp.

Homogenizers.....develop & use all the energy right in the liquids with only 1/6 to 1/10 the power. Technical bulletin gives all the facts.
L179 *Sonic Engineering Corp.

Liquid Return System.....Complete information on the installation, operation and maintenance of a line of liquid return systems for ammonia refrigeration systems.
177A H. A. Phillips & Co.

Lubricators.....The Force Feed Lubricator features dependable, accurate lubrication. Catalog gives complete data on all the lubricators.
T186 *Manzel

Mills, Impact.....New bulletin tells efficient method of achieving particle size reduction by centrifugal force. Available in sizes to meet individual requirements.
177B Safety Industries, Entoleter Div.

Mist Eliminators.....Latest design guides in the recommended type & method of installation best suited to your particular operating conditions are available. Bul. ME-9.
152 *Metal Textile Corporation

Mixer.....The Mix-Muller features large hoods, spring loaded mullers, removable crib section and bottom discharge. A new bulletin on mulling is now available.
53 *National Engineering Co.

Mixer, Batch.....produces finished product in one operation. A new catalog describes the Troy line of angular mixers, colloid mills, roller mills & unit blenders.
BL189 *Troy Engine & Machine Co.

Mixers.....The complete line of fluid mixers range from fixed-mounted 40 H. P. turbines & heavy-duty propeller mixers to lightweight portables. Handbook offered.
168a *Eastern Industries, Inc.

Mixers.....You'll find a wealth of information on fluid mixing in bulletins describing Lightnin Mixers. A condensed catalog shows all types. No. B-109.
192 *Mixing Equipment Co., Inc.

Mixers.....Important design advantages include, extra large, heavy duty bearings throughout & extra long out-put shaft bearing span. All information in Catalog A-27.
157 *Philadelphia Gear Corp.

* From advertisement, this issue

LITERATURE . . .

Mixers Centrifugal.....A compact unit adaptable to continuous or botch system. Offers increased capacities, with agglomerate reduction, colors intensified.
178A Safety Industries, Entoleter Div.

Mixers, Side-Entering.....Handles the extra heavy-duty jobs in big tanks. Available in sizes ¼ to 30 H. P. Complete information in Bulletin 620.
168b *Eastern Industries, Inc.

Mixers, Top-Entering.....Designed for heavy-duty applications requiring agitators from ¼ to 10 H. P. Bulletin No. 620 gives the complete story.
168c *Eastern Industries, Inc.

Mixers, Turbine.....Bulletin 1210 contains details on these turbine mixers which solve many special mixing problems. Available in a range of ¼ to 40 H. P.
168d *Eastern Industries, Inc.

Reactors.....Solids contact reactor is designed to provide ultimate in clarification. Features Radial Horizontal Flow-Not Upflow. Velocity decreases from center to launder.
25 *Cochrane Corporation

Samplers, Automatic.....Wet, dry, dust tight units, multi-stage sampling, continuous or intermittent operation & complete sampling systems available. Bulletin No. S1-B4.
156 *Denver Equipment Co.

Screens.....featuring separations from 12 inches to 325 mesh. Can handle wet or dry operations. A valuable screen selection guide, outlines the complete line.
129a *Allis Chalmers

Screens.....New 12-page bulletin describes and illustrates latest models of Selectifier Screens for pulp and paper-mill application. Installation diagrams.
178B Black Clawson Co.

Screens, Vibrating.....Important new design, compact, high capacities, low power requirements for long life under rugged conditions. Available in all sizes.
178C Safety Industries, Entroleter Div.

Separator, Electrostatic.....Literature is available on the new Coronatron electrostatic separator with low intensity design or with exclusive sparkless electrode.
R179 *Dings Magnetic Separator Co.

Towers.....Technical bulletins: "Test Your Towers" and "Analyze Your Bids" feature facts of interest on industrial towers. Available on request.
190 *The Marley Company

Turba-Film Processor.....has wide applications in atmospheric and low vacuum ranges. Literature is now available with details for your requirements.
34A *Rodney Hunt Machine Co.

Vacu-Film Processor.....extends the range of thin-film processing into high vacuum . . . to one-half micron. Literature contains details for your requirements.
34b *Rodney Hunt Machine Co.

Compressed-Air Filters.....New booklet covers the complete line of Fulflow filters for compressed air and other gases. Rates to 800 scfm.; pressures to 4,000 psi.
178D Commercial Filters Corp.

* From advertisement, this issue

LITERATURE . . .

Pumps, Blowers, Compressors

Blowers & Exhausters.....New bulletin outlines the important advantages in pressure range, size, weight, cost and service. Included are illustrations & specifications.
179A M-D Blowers, Inc.

Pumps.....decreased down-time to a minimum . . . maintenance costs reduced substantially. Full information available as to installation & Maintenance.
69 *Aldrich Pump Co.

Pumps.....The Series H-2 Durcopumps feature the new bearing seals of Teflon. This device is leakproof and lubricant is positively sealed in.
131 *The Duriron Co.

Pumps.....for abrasive and corrosive applications are featured. Helpful "Pump Selector" is now available on request. A type for every requirement.
TL189 *Nagle Pumps, Inc.

Pumps.....Complete information on horizontal and vertical designed pumps for your pumping needs. Two bulletins are now available. No. C-355 and No. V-837
L176 *Taber Pump Co.

Pumps, Fire.....available for high pressure sprinkler systems, or foam smothering systems in every kind of commercial or industrial installation. Bul. B-1500.
151 *Food Machinery & Chem. Corp.

Pumps, Vertical.....with no submerged bearings for pumping abrasive corrosive slurries. Bul. 203-7 for complete summary of acid & chemical pump data.
158 *Lawrence Pumps, Inc.

Services, Processes, Misc.

Boxockets.....Wrenches are hammer-forged from finest steel & heat-treated to exact standards for long life under tough use. A new tool catalog is offered.
161 *Snap-On Tools Corp.

Cleaning Equipment.....6 p. "Time-Saving Procedures for Cleaning Chemical Processing Equipment" describes application method, choice of equipment.
179B Oakite Products, Inc.

Cleaning Heat Exchangers.....2 p. leaflet, "How to Clean Heat Exchangers in Place," tells how to handle several typical examples. Lists supplies needed.
179C Oakite Products, Inc.

Cleaning, Mechanized.....12 p. booklet describes the equipment available to accommodate mechanized application of various cleaning solutions.
179D Oakite Products, Inc.

Cleaning Pharmaceutical Plants..... 2 p. flyer has sections on cleaning fermentation tank interiors, painted surface of tank walls solvent recovery stills.
179E Oakite Products, Inc.

*From advertisement, this issue

ADAMS FACT FILE #3

INSTRUMENT AIR

Clean Dry Air Supply Will Reduce Production Down-Time . . . Instrument Maintenance . . .

Wet, dirty compressed air has no place in the process industries. In instrument air supply lines it can cause havoc. Whether it be motor air in a control circuit or supply air to the control panel, absolutely clean dry air is vital. Moisture elimination is the major consideration in providing suitable air for instrument and control systems.

Since most plant compressors in use today are oil lubricated, a finite amount of oil is present with the water vapor in the discharge. This carry-over condenses as an oil-water emulsion which often causes serious fouling of instrument components. To eliminate this oil-moisture condensate in the air lines, it is necessary to remove it before it reaches the distribution system. This is done by cooling the air before the receiver. It is advisable to cool well below the ambient conditions to provide the lowest possible humidity at the instrument panel or control units.

Two Stage System Design for Economy

The ideal method to achieve high quality air is a two-step operation.

1—An Adams Aftercooler . . . providing 2° F. cooling . . . and Cyclone Separator installed between the compressor and receiver to remove the bulk of moisture carry-over.

2 — A chemical dryer installed down stream to provide the polishing action necessary for the desired minimum humidity.

Thus, the bulk of water . . . 90% . . . is removed by the Aftercooler-Separator using plant water for cooling. A minimum moisture load is then left to be removed by more expensive methods. Under normal circumstances, all of the oil present in the compressor discharge will be removed in the Aftercooler-Separator. Fouling of the chemical unit is then virtually eliminated.

Poro-Stone Air Filter at Panel Provides Dirt-Free Control Air . . .

In spite of the efficiency of the Adams Aftercooler and Separator, there still will be some dust and dirt present in the instrument air system. That's why it is advisable to install an Adams Poro-Stone Air Filter in the line just before the control panel.

Separation by the Adams unit is in two stages — centrifugal and diffusion. Centrifugal force throws the foreign matter to the walls of the filter body where it is trapped in slots and drained. Remaining particulate matter is removed as the air passes through the pores of the Poro-Stone element.

This final protection for your instruments will minimize control system failures and process down-time. Instrument maintenance will be sharply reduced.

Literature Will Help Air System Design

For further information on how the complete line of Adams air equipment can help you provide a foolproof instrument air supply, write today for your copy of Bulletin No. 712 on Aftercoolers and Separators and Bulletin No. 117 on Poro-Stone Air Filters to the R. P. Adams Company, Inc., 207 East Park Drive, Buffalo 17, New York.

LITERATURE . . .

Cleaning Rubber Molds.....4 p. "How to clean Rubber Molds" covers tested techniques, factors influencing cleaning, use of alkaline type detergent, electro cleaning.
180A Oakite Products, Inc.

Cleaning, Steam Detergent.....2 p. leaflet describes a variety of steam gun models and the conditions to which they are best suited. Photographs.
180B Oakite Products, Inc.

Comprehensive File of Trademarks .....used by CPI here & abroad is available, at a charge. Included are, registered, unregistered, technological names.
17-18n *U. S. Industrial Chem. Co.

Cryogenics.....New 12-page brochure covers, in text and pictures, subjects pertaining to cryogenics, nuclear engineering and ground support facilities.
180C Stearns-Roger Mfg. Co.

Fabrication.....Brochure "Heavy Steel Fabrication" is avaiable on request. Outlines a wide range of products & services for the chemical & petrochemical industries.
164 *Avondale Marine Ways, Inc.

Fabrication.....Reboiler made of all carbon steel . . . one of the many products designed & fabricated. Design practical trouble-free equipment to all codes.
144 *Manning & Lewis Co.

Infrared System.....Long-path system recently developed is said to detect evaporation from one drop of a predetermined chemical in an average room. No. 1436.
17-18e *U. S. Industrial Chem. Co.

Nuclear Fuels......"Nuclear Fuels: Key to Reactor Performance" discusses reactor design, reactor fuels and a summary of typical and historical reactors and their fuels.
180D Sylvania-Corning Nuclear Corp.

Polyethylene Fabrics.....A patented technique for finishing is now being employed to improve shrink resistance, strength, appearance & other physical characteristics.
17-18c *U. S. Industrial Chemicals Co.

Polyethylene work gloves.....claimed to provide protection without loss of fingertip sensitivity. Lightweight, waterproof and resistant to most chemicals.
17-18m *U. S. Industrial Chem. Co.

Scale Removal.....8 p. "Controlled Chemical Removal of Lime Scale and Rust" tell how to make best use of inhibited chemical cleaning compound, designated No. 32.
180E Oakite Products Inc.

Slide Rule.....has special scales for chemists solving pressure, temperature, solution concentration problems on one face, standard scales on other face.
17-18h *U. S. Industrial Chem. Co.

Tool....."Safety Boy" is lightweight & easy to carry. Spreads all types of flanged pipe conections. Handy for working in tight working space. Catalog Sheet.
TL187 *Wm. L. Riggs Co.

Welding.....Methods and specific information are oulined in the illustrated Weldment Bulletin 7001. The welding of pressure vessels is one of the many jobs detailed.
84 *Baldwin-Lima-Hamilton

* From advertisement, this issue

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SELLING OPPORTUNITY OFFERED

Manufacturer of Heat Exchangers and Pressure Vessels, located in New Jersey, wants sales representatives in various parts of country. Representatives should have contacts in oil refineries, power plants, chemical plants or marine: RW-8806, Chemical Engineering.

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SPECIAL OFFER

12—**UNUSED BAKER PERKINS** #15 JIM2 DOUBLE ARM, STEAM JACKETED MIXERS, 100 GAL. OPERATING CAPACITY, HYDRAULIC TILT, 20 HP MOTORS.

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1—20,000 gal. 347 S.S. Vertical Storage Tank 12' x 23'.
1—Struthers Wells 4000 gal. Horizontal 316 S.S. Tank with Agitator.
1—3500 gal., 304 S.S. jacketed, agitated Tank, 9' x 7'.
1—Haveg 4000 gal. closed Storage Tank.
1—750 gal. nickel clad Mixing Tank, 125# internal, with nickel coils.
1—10,000 gal. Horizontal Steel Pressure Tank, 200# psi.
1—Blaw-Knox 1400 gal. steel, jacketed, agitated Vacuum Kettle.
4—Buflovak 750 gal. steel, jacketed, double motion paddle, agitated Kettles.
1—4000 gal. 347 S.S. jacketed Reactor, 150# internal.
2—Pfaudler 1500 gal. glass lined, jacketed, agitated Reactors, 90# jacket.
1—Blaw-Knox 500 gal. 347 S.S. clad, jacketed, agitated Reactor.
2—Patterson 1000 gal., steel, jacketed, agitated Reactors, 20 HP.
1—3000 gal. 316 S.S. Reactor 7' x 10' with Turbo Agitator.
3—Louisville 8' x 50' stainless steel lined Rotary Dryers.
3—American 42" x 120" Double Drum Dryers, 10 HP motors.
1—Buflovak 48" x 40" nickel, single drum Flaker.
2—Buflovak 250 & 20 sq. ft., 304 S.S. forced circulation Evaporators
1—Buflovak 550 sq. ft. Monel Single Effect Evaporator.
5—Stainless Heat Exchangers, 1220, 1080, 786, 500, 370 sq. ft.
1—Bird 24" CH stainless steel Continuous Centrifuge.
1—Bird 48" Fume tight 316 S.S. suspended Centrifuge.
2—Sharples PN14 & PY14 Super-D-Canters, 316, S.S.
1—Sharples H2 Nozzlejector, 15 HP, 304 S.S.
1—Bird 40" suspended Centrifugal; 347 S.S. imperforate basket, 1800 rpm.
2—Sharples C20 & C27 Super-D-Hydrators, 316 S.S., vapor tight XP Timers.
1—Bird 18" x 28", 316 S.S. continuous Centrifuge.
2—Sparkler 33-S-28 Pressure Filters, 150 sq. ft., 304 S.S.
1—Niagara 36 H-110 horizontal 304 S.S. Filter, 110 sq. ft.
1—Baker Perkins #16 TRM, 150 gal., jacketed sigma blades, Vacuum Mixer.
3—Stokes R single punch Tablet Machines, Unused.
1—Vulcan Briquetting Press, 30" dia. x 12½" face, 304 S.S. rolls, 50 HP.
1—Dowtherm 360,000 BTU Vaporizer.

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4—Ruggles-Coles Class #XA-18 double shell indirect-direct heat rotary dryers, 104" x 70' x ⅝" shell.
4—Komarek-Greaves briquetting presses, 75 HP, 25 tons per hour.
4—Komarek-Greaves vertical Fluxers (paddle mixers), 150 HP.
4—K-G Horiz. Fluxers 41" dia., 50 HP.
4—K-G Pug Mills, 30" dia. x 14'4".
8—Tyler Screens, 4' x 8', 4' x 6'.
2—42" wide travelling-screen cooling conveyors, total of 950'.
4—36" x 24", 24" x 18" Jeffrey hammermills, 50 HP, 25 HP.
6—Robinson Sawtooth Crushers.
2—Pa. Crusher #C-3-30 hammermills.
20—Welded Steel bins, cone bottom, from 15,000 gallon to 90,000 gallon.
4—Keeler Boilers 200 HP, 160 PSI.
8—16" & 24" trough-belt conveyors, 100', 250', 500' long.
6—36' & 48" apron feeders, 8' long.
8—Bucket elevators, 62' and 90' c-c.
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1—Buflovak 42" x 90", atm.
2—American 36" x 84", Vacuum
1—Buflovak 32" x 72", atm.
1—Buflovak 32" x 52", atm.
1—Witteman 22" x 38", atm.

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3—Sparkler #33-S-28, T304 SS, 151 sq. ft.
1—Niagara #510-28, T316 SS, 510 sq. ft.
1—Niagara #36H-110, T304 SS, 100 sq. ft.
1—Niagara #80-30, T304 SS, 80 sq. ft., Jkid.
1—Niagara #45-30, T304 SS, 45 sq. ft.
3—Sweetland filters: #12, 7, 5
1—Alsop #SD-12-WR-30, T316 SS
2—Sperry 30" filter presses, niresist

TABLET PRESSES

3—Stokes #R, single punch, UNUSED
2—Stokes #T, single punch
2—Stokes #DDS-2 rotary
1—Stokes #RD-4 rotary
2—Kux #25 rotary
1—Kux #64, single punch

CENTRIFUGALS, CONTINUOUS

1—BIRD 18" x 28", T304 SS, CONICAL BOWL.
1—Bird 18" x 28", steel solid bowl
4—Bird 24" x 24", monel, slotted screen
1—Bird 24" x 38", monel, horiz. bowl
1—BIRD 32" x 50", T316 SS, HORIZ. BOWL.
1—Bird 40" x 60", T304 SS, horiz. bowl
1—Sharples Model G-2, tinned steel
2—SHARPLES C-20 SUPER-D-HYDRATORS, T316 SS
1—SHARPLES C-27 SUPER-D-HYDRATOR, T316 SS
1—SHARPLES C-27 SUPER-D-HYDRATOR, Monel
2—SHARPLES #PN-14 SUPER-D-CANTERS, T316 SS
1—SHARPLES #PY-15 SUPER-D-CANTER, T316 SS
1—Sharples #AS-16, T304 SS, Separator
6—Sharples #16, T304 SS, Clarifier
2—Sharples #18-V, steel, vapor tight
2—DeLaval #BUH-3930, SS, clarifier
1—Baker-Perkins "Teer Meer" #HS-10, T316 SS

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1—Marcy 7' x 15' rod, 300 HP
4—A-C 7' x 24' compeb, 450 HP
4—A-C 5'6" x 22' ball-tube, 150 HP
1—A-C 6' x 15' ball, 150 HP
1—A-C 6' x 16' ball, 30 HP
1—Denver 4' x 10', rod, 60 HP
1—Hardinge 4'6" x 16' concial, 25 HP
1—Kennedy 3' x 6' ball, 50 HP

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2—Nickel clad evaporators, 400 & 250 sq. ft. vert. long tube.
1—Stokes evaporator, 236 sq. ft., double effect, T316 SS
2—Buflovak evaporators, 250, 20 sq. ft., forced circulation, T304 SS.
1—Struthers-Wells evaporator, 625 sq. ft., T347 SS, full vacuum.
3—Sanitary Vacuum Pans, 6' dia. SS, internal coils.
1—B & S evaporating kettle, 600 gal. SS, 6' dia. agit.

ROTARY KILNS

1—11' x 155' Traylor, ⅞" shell
1—9' x 100' Vulcan, ⅝" shell
1—8' x 170', ¾" shell, 3-tire
1—8' x 126' Vulcan, ¾" shell
1—8' x 115', ⅝" shell, 2-tire
2—8' x 50' Vulcan, ⅝" shell
2—7'6" x 100', ½" shell, 3-tire
2—6' x 60' Vulcan, ⅝" shell
1—4' x 24', 2-tire

CENTRIFUGALS, BASKET

1—A.T.&M. 48" DIA. SUSP., T304 SS PERF. BASKET, VAPOR TIGHT, 30 HP
1—TOLHURST 40" SUSP., T316 SS PERF. BASKET
1—Bird 40" susp., steel imperf. basket
1—Fletcher 40" susp., steel perf. basket
1—Fletcher 30" susp., T304 SS, perf. basket
1—Fletcher 30" underdriven, T304 SS perf. basket
1—Tolhurst 26", underdr., T316 SS, XP
1—Fletcher 12" underdriven, T304 SS solid basket

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Colloid Mills Stainless Steel 5 & 1½ HP.
Mixers: Baker Perkins Jack. 100 gals.
Day Imperial 75 & 150 gals. Jack.
Day Pony Mixers 8, 15 & 40 gals.
Day Jumbo 700 gal. horiz. mixer.
Blystone 3000# horiz. spiral mixer.
Dry Spiral Mixers 50 to 3000#.
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Gould 75 HP Centrifugal 250 PSI.
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Ball Mills 6'7"x6', 7'x6' & No. 96
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310-16 Link-Belt Roto Louver Dryer
9'x130' Rotary Kiln
Model SD 85-25 Hiel Dehydrator
5'x12' Allis-Chalmers Ripl-flo Vibr. Screen

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No matter how you look at it!

GELB
CHEMICAL PROCESSING EQUIPMENT

Says "VALUE, VALUE, VALUE"!

3—Louisville stainless steel rotary dryers 8' x 50', complete
1—Steel and Alloy Tank Co. 3000 gal. type 316 S.S. Jacketed reactor, complete with agitator and drive
1—Vertical 8000 gal. type 347 SS tank
1—4000 gal. horizontal type 316 SS tank with dished heads

THE GELB GIRL—JANUARY 1959

AUTOCLAVES, KETTLES AND REACTORS:

1—100 gal. type 316 SS jacketed reactor, 150# internal pressure, 75# jacket with impeller type agitator
1—Walter SS jacketed reactor, 500 gal.
4—Pfaudler 750 gal. SS jacketed reactors
5—Pfaudler 500 gal. SS jacketed reactors
5—Pfaudler glss lined jacketed reactors, 20 to 300 gal.
1—Tippett & Wood 2500 gal. jacketed steel kettle
1—Combustion Engrs. 1600 gal. jacketed steel autoclave, 150# jacket, 600# internal pressure
1—Horizontal 5000 gal. nickel storage tank
2—Columbia Engineering high pressure storage tanks, 2400 gal., 265# working pressure

DRYERS:

4—Link Belt steel roto louver dryers, Model 207-10, 310-16, 310-20, 604-20
1—Buflovak double drum dryer, 42" x 120"
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
1—Stokes double drum dryer, 5' x 12'
1—Louisville rotary steam tube dryer, 8' x 45'
1—Louisville SS rotary kiln, 30" x 28', complete
1—Stokes SS rotary vacuum dryer, 2' x 6'
6—Stokes steel jacketed rotary vacuum dryers, 3' x 15'

FILTERS:

1—Oliver horizontal filter, 6'6"
1—Sweetland #3 SS filter
1—Niagara SS filter Model 510-28
1—Oliver horizontal filter, 3'
1—Feinc SS rotary vacuum string filter, 3' x 3' (NEW)
10—Shriver plate and frame filter presses, 12" to 42"
1—Shriver rubber lined filter press 36" x 36"

MIXERS:

5—Baker Perkins double arm sigma blade mixers, 100 gal.
3—Robinson type 316 SS sigma type jacketed heavy duty mixers, 300 gal. 60 HP
3—Howes 40 cu. ft. rubber covered ribbon blenders
1—Leader SS jacketed 51 cu. ft. ribbon blender.

MISCELLANEOUS:

2—Heat Transfer Products steel bubble cap columns, 36" and 42" with 5 and 10 trays
1—Acme steel bubble cap column 42" dia. with 10 trays
1—Downington Iron Steel bubble cap column 24" dia. with 14 trays
2—Patterson Kelley, steel heat exchangers, 1000 sq. ft. each
6—Struthers Wells heat exchangers, 885 sq. ft.
1—Patterson Kelley steel heat exchanger, 427 sq. ft.
50—Steel heat exchangers from 15 sq. ft. to 400 sq. ft.
30—Struthers Wells SS heat exchangers, 650 sq. ft. each
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
2—Stokes tablet presses, Model T
1—Swenson type 316 SS vacuum crystallizer, 3'6" x 12'
1—Swenson type 316 SS vacuum crystallizer, 2'6" x 12'
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Badger type 316 SS bubble cap column, 42" dia. with 11 trays
1—Stokes Model DDS2 rotary tablet press

1—Bird type 316 S.S. suspended type centrifuge, 48", with perforate basket, complete with motor, plow and fume type cover
12—Sweetland #12 filters with 72 SS leaves
1—Sharples #16P pressuretite SS super centrifuge
1—Stokes SS rotary vacuum dryer, 3' x 15'

Established 1856

R. GELB & SONS, Inc.,

CHEMICAL, RUBBER, OIL, PLASTIC and FOOD PROCESSING MACHINERY

U.S. HIGHWAY No. 22, UNION, N.J. • MUrdock 6-4900

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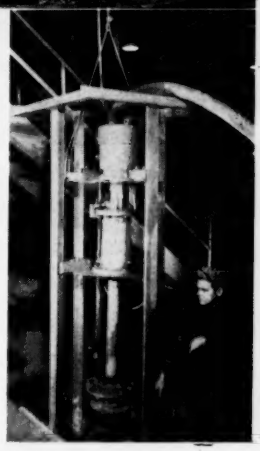

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NAGLE PUMPS, INC.
1235 CENTER AVENUE, CHICAGO HEIGHTS, ILLINOIS

PUMPS FOR ABRASIVE AND CORROSIVE APPLICATIONS

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DUPLEX DISPERSER*
POWERFUL BATCH MIXER

Produces Finished Product in One Operation

Est. 1870
TROY

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A flexible compact unit that combines a powerful disperser head with a rugged diamond-shaped agitator to produce finished homogeneous batches without further processing—for most chemicals, inks, plastics, pharmaceuticals, cosmetics, paints, and industrial finishes.

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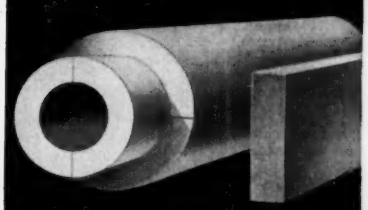
ONE-LAYER INSULATION!

Now a modern molded calcium silicate insulation for use on today's high temperature pipes and vessels. Insulates with only *one* layer, providing a constant co-efficient of conductivity. Available in various thicknesses of pipe coverings and blocks, Calsilite is insoluble in water, can withstand normal acids and alkalis . . .



FOR SOAKING HEAT UP TO 1250° F!

- Light weight
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- Absorbs moisture without disintegration

For complete details, write:

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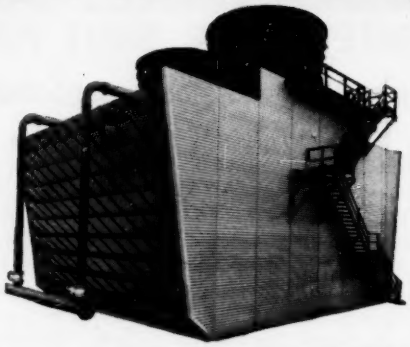
PIONEERS IN CALCIUM SILICATE INSULATION

1958 TOWER TESTS

Marley's 3rd Annual Report to Industry

The day of "hazard buying" of cooling towers is past. To substantiate this, Marley encourages purchasers to TEST YOUR TOWER and each year publishes the results of these tests. This list of tests is not selected or edited—it is a consecutive record of ALL tests of Marley Cross-Flow towers during 1958. Seventeen tests were conducted according to accepted test code procedure—*more than reported by all other manufacturers combined.*



TEST NO.	TYPE OF SERVICE AND LOCATION	SPECIFIED CONDITIONS				TEST RESULTS	
		Gallons Per Minute	Hot Water Temp.	Cold Water Temp.	Wet Bulb Temp.	Degrees Cold Water Temp.	Percent Capacity
1*	Petroleum Refinery—North Central	5,200	120°	84°	74°	+0.44°	+3.5%
2*	Chemical Process—Mountain States	7,000	90°	75°	65°	+0.65°	+7.2%
3*	Power Plant—West Coast	31,500	109.4°	91°	80°	+0.35°	+2.6%
4†	Petroleum Refinery—Gulf Coast	28,000	113°	93°	82.5°	+0.37°	+2.9%
5†	Petroleum Refinery—Gulf Coast	16,000	112°	91.5°	82.5°	+1.50°	+9.6%
6*	Power Plant—Mid-Central	14,750	102°	87°	75°	+0.40°	+3.1%
7	Petroleum Refinery—Gulf Coast	25,000	120°	95°	82.5°	−0.30°	−2.0%
8†	Power Plant—Mid-Central	7,000	96°	85°	75°	−0.05°	−0.5%
9*	Petroleum Refinery—North-Central	9,300	110°	84°	74°	+0.40°	+3.0%
10	Power Plant—Mid-Central	9,500	100°	86°	75°	+0.10°	+0.8%
11†	Power Plant—Mid-Central	16,000	102.2°	90°	75°	+0.30°	+2.0%
12†	Petroleum Refinery—Mid-Central	23,250	106.5°	88.5°	77°	+1.60°	+12.6%
13	Power Plant—Mid-Central	60,000	99°	84°	74°	+0.30°	+3.1%
14†	Petroleum Refinery—Gulf Coast	45,000	112°	89°	82.5°	−0.54°	−5.2%
15	Petroleum Refinery—Gulf Coast	6,000	115°	85°	79°	+0.30°	+3.6%
16	Air Conditioning—Mid-Central	4,200	96°	85°	78°	+0.30°	+3.5%
17*	Power Plant—Mid-Central	44,000	99.5°	86°	74°	+0.80°	+7.2%
18†	Power Plant—Southwest	61,500	106.5°	88.5°	76.5°	+1.20°	+11.0%
19*●	Petroleum Refinery—East-Central	8,000	115°	85°	75°	+0.50°	+4.0%
20†	Petroleum Refinery—Gulf Coast	57,500	120°	85°	79°	−0.03°	−0.03%
21	Petroleum Refinery—Gulf Coast	18,830	112°	85°	79°	+0.14°	+1.5%
22†	Petroleum Refinery—Gulf Coast	34,000	113.5°	87.5°	80°	+0.12°	+1.2%

*Code Test (observer not present) †Code Test (observer present)

Here is positive proof of "in service" performance—the strongest possible assurance that Marley towers are bid and built to equal or exceed specified performance. If you believe with Marley that every industrial tower owner is entitled—if not obligated—to know the capability of his tower, before and after installation, write today for these Marley technical bulletins: "Analyze Your Bids" and "Test Your Tower."

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Kansas City, Missouri

Many Industrial Plants Use Both

SAND PUMPS

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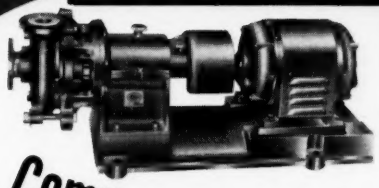

ACID PUMPS

Companions in Economical Operation

Industrial operations requiring both sand pumps and acid pumps are increasing almost daily. And now, more than ever before, efficient, low-cost pumping is a prime consideration. For this reason many plant operators choose the Wilfley team. They know Wilfley sand pumps and acid pumps consistently increase production and reduce operating costs. Wilfley's long-standing record of day-in, day-out dependability is a record *you* can rely on. Put Wilfley pumps to work now . . . every installation is job engineered to give you maximum efficiency and economy.

Write, wire or phone for complete details.

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DORR-OLIVER designed, engineered and supplied all equipment for this 600-ton/day triple superphosphate plant of American Cyanamid Company at Brewster, Fla. Phosphoric acid is produced in the reactor tanks at right of open-air building. Premixers, reactors, small tank and sump in foreground are all equipped with LIGHTNIN Mixers.

What helped this Cyanamid plant **exceed design capacity** *in less than three months?*

200,000 tons a year of triple superphosphate fertilizer—that's the record-breaking production at this American Cyanamid Company plant.

Designed, engineered and equipped by Dorr-Oliver Incorporated, the plant reached its design capacity and guaranteed yields less than three months after initial startup.

How did they do it?

One part of the answer is good mixing. Three of the major operations—reaction, evaporation, water reclamation—employ LIGHTNIN Mixers.

Optimum reactor yield

Every day, over 700 tons of phosphate rock and 600 tons of 98% sulfuric acid flow into the plant's two big premixers and four reactors. One 30-horsepower and five 60-horsepower turbine-type LIGHTNIN Mixers provide the intense but controlled agitation necessary to obtain maximum yields of 32% P_2O_5 phosphoric acid and coarse, uniform, fast-filtering gypsum.

In the three-stage vacuum evaporator system, turbine-type LIGHTNINs keep the three seed tanks uniformly mixed.

Contaminated water at 3200 GPM is neutralized in two LIGHTNIN-equipped tanks, clarified in a 90-foot diameter Dorr Clarifier, cooled and reused, while acid wastes are neutralized in two other LIGHTNIN-mixed tanks prior to discharge.

"Good mixing" is the reason why Dorr-Oliver purchased LIGHTNIN Mixers throughout this record-toppling plant—and why LIGHTNINs are used in many plants designed by this experienced firm.

MORE THAN 1000 TONS of gypsum and 650 tons of 32% P_2O_5 phosphoric acid a day are handled by one 30-HP and five 60-HP LIGHTNINs, largest mixers ever used for this purpose.

TURBINE-TYPE LIGHTNINs in the seed tanks of American Cyanamid's vacuum evaporator station concentrate phosphoric acid from 32% to 54% P_2O_5.

What this can mean to you

How important is good mixing in *your* process? For mixers that can help you get a new plant onstream faster . . . give you *guaranteed* answers to mixing problems . . . and trim fluid mixing costs to a minimum—see your LIGHTNIN Mixer representative. He's listed in Chemical Engineering Catalog. Or write us direct.

WHAT MIXING OPERATIONS are important to you? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 128-a Mt. Read Blvd., Rochester 3, N.Y.

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Lightnin® *Mixers*

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